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Revision of the Oriental genera of Agathidinae (Hymenoptera, Braconidae) with an emphasis on Thailand including interactive keys to genera published in three different formats

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Abstract

The genera of Oriental Agathidinae are revised and a fully illustrated dichotomous key is presented. New generic concepts are proposed for *Bassus* Fabricius, 1804 and *Hypsostypos* Baltazar, 1963. *Bassus* is restricted to a clade with an Old World distribution and the remaining members are divided amongst the resurrected genera *Camptothlipsis* Enderlein, 1920, *Lytopylus* Förster, 1862, and *Therophilus* Wesmael, 1837. The concept of *Hypsostypos* is restricted and the new genus *Amputostypos* Sharkey, **gen. n.** is proposed to include species formerly included in *Hypsostypos* that do not have raised antennal bases. *Troticus* Brullé, 1846 is reported from the Oriental region for the first time. Eighteen genera are recognized for Thailand and neighboring areas, i.e., *Agathis* Latreille, 1804, *Amputostypos*, *Aneurobracon* Brues, 1930, *Bassus*, *Biroia* Szépligeti, 1900, *Braunsia* Kriechbaumer, 1894, *Camptothlipsis*, *Coccygidium* Saussure, 1892, *Cremnops* Förster, 1862,

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Disophrys Förster, 1862, *Earinus* Wesmael, 1837, *Euagathis* Szépligeti, 1900, *Gryochus* Enderlein, 1920, *Hypsostypos*, *Lytopylus* Förster, 1862, *Therophilus*, *Cremnoptoides* van Achterberg & Chen, 2004, and *Troticus*. Identification keys to the genera are provided as a standard textual dichotomous key, as well as online keys in three different formats (conventional dichotomous, DELTA/Intkey, Lucid, and MX) to enable users to choose their prefered platform and to allow direct comparisons of the technologies for producing online keys. Publication of underlying data (data matrices, character states table, and images) under the OpenData-Commons license (ODbl) (http://www.opendatacommons.org/licenses/odbl/1.0/) for DELTA/Intkey files (doi: 10.3897/zookeys.21.271.app.1.ik), primary DELTA files (10.3897/zookeys.21.271.app.2.ik) Lucid3 (LIF3) and Lucid SDD key data files (doi: 10.3897/zookeys.21.271.app.3.ik) and MX MySQL database files (doi: 10.3897/zookeys.21.271.app.4.ik) allows future workers to edit keys and to add newly described taxa. The data files for the keys published and stored on the publisher's website and in e-archives have the rights of "first publication" identified by its bibliography data, location and citation. Readers should cite the first published version and the day of accession in case they use future online versions of the same key. The concept of publication, citation, preservation, and re-use of data files to interactive keys under the open access model is discussed in a forum paper published in the present issue (doi: 10.3897/zookeys.21.274).

Keywords

Ichneumonoidea, Braconidae, new genus, new combination, new synonym, new status, identification key, interactive keys, data publishing

Introduction

Agathidinae is a moderately large subfamily of Braconidae with 1,061 described species worldwide and 238 in the Oriental Region (Yu et al. 2005). Though there are an estimated 2,000–3,000 species awaiting description worldwide (Sharkey et al. 2006). The subfamily has a worldwide distribution and members are found in most terrestrial habitats. Though all known species are koinobiont endoparasitoids of lepidopteran larvae, life history traits vary considerably. Depending on the species, they may be nocturnal or diurnal, gregarious or solitary, attack exposed or concealed hosts, and attack any larval instar. In general they are solitary, attack first-instar Lepidoptera larvae in concealed microhabitats such as leaf-rolls or stems, and emerge from the last larval instar of the host after it has spun its cocoon. Detailed studies of life history have been conducted for a few species (e.g., Simmonds 1947, Dondale 1954, Odebiyi and Oatman 1972, 1977, Janzen et al. 1998) and a few have been used in classical biological control efforts. Currently there are about 50 genera recognized (Sharkey 1992).The history of higher classification of the Agathidinae was summarized by Sharkey (1992) who also proposed a tribal-level classification based on groundplan coding.

Sharkey et al. (2006) conducted phylogenetic analyses based on morphology and the D2–3 regions of 28S rDNA. Perhaps their most noteworthy result was a clear demonstration of the polyphyletic nature of the genus *Bassus*, however it was beyond the scope of the paper to adjust generic classification. Here we begin to correct this problem by resurrecting two junior synonyms of *Bassus* and restricted *Bassus* s.s. to a relatively small Old World clade.

The Oriental fauna of Agathidinae were revised by Bhat and Gupta (1977) and they provided a detailed history of taxonomic research for the area. Many of the generic

concepts have changed since their publication and here we revise and update the generic concepts and provide a key to genera. This is a prelude to a complete revision of all of the species of Agathidinae found in Thailand funded by a USA, NSF grant to explore the terrestrial insect fauna of Thailand. As part of the inventory of Thai insects we have run 3 Malaise traps at 30 different localities throughout Thailand since 2007, comprising approximately 90 Malaise trap years.

Materials and methods

Material for this study was primarily collected in Malaise traps operated throughout Thailand since 2007. Raw Malaise trap samples were sent to the Queen Sirikit Botanic Gardens (QSBG) in Chaing Mai, Thailand, where the Agathidinae and many other taxa were separated. These were then sent to the Sharkey lab in Lexington, Kentucky where they were treated in hexamethyldisilazane, mounted, and labeled. Most species have been sequenced for COI and the D2–3 regions of 28S. Holotypes of all material will be returned to QSBG. For more details on the Thai inventory visit http://sharkeylab.org/tiger/.

Images for this study were taken with an Automontage© imaging system mounted on a Leica MZ16 stereomicroscope. The taxonomic decisions were based primarily on the analyses published in Sharkey et al. (2006) many of which have been confirmed by more recently obtained unpublished sequence data.

Following the key to genera, below, each genus is treated in alphabetical order. Included in these treatments are discussions of distribution, diversity, phylogeny, biology, and diagnosis. Where warranted, a section on taxonomic decisions is included. Each generic treatment includes a full lateral habitus and an image of a forewing. There are also three published interactive keys available. They are in the following formats: Intkey, Lucid, and MX.

The dichotomous key was generated using DELTA software (http://delta-intkey.com). Data, species names, characters and character states were entered into Delta Editor (Dallwitz 1980; Dallwitz et al. 1999). The "tokey" file was edited to select and weight the characters used for the dichotomous key, and the modified file was exported from DELTA to produce the key which was then lightly edited to produce the final version (Dallwitz 1974; Dallwitz 1980; Dallwitz, Paine, and Zurcher 1993). The Intkey was produced in a similar manner using the DELTA file "toint" and the software Intkey (Dallwitz 1980; Dallwitz, Paine, and Zurcher 1993; Dallwitz, Paine, and Zurcher 1995). All source files and images used in this publication are available at http://sharkeylab.org/sharkeylab/Misc/datasets/DeltaFiles/AgathidinaeThaiDeltaFiles.zip and in Appendices 1 and 2 of the present paper (doi: 10.3897/zookeys.21.271.app.1.ik and doi: 10.3897/zookeys.21.271.app.2.ik). These files are open to the public and future researchers are welcome to download them if they wish to modify, correct, or add newly described taxa for identification.

Online interactive matrix and dichotomous keys were also produced using Lucid (www.lucidcentral.org), and are available on Waspweb at: http://www.waspweb.org/Ichneumonoidea/Braconidae/Keys/index.htm. Users can choose between three different key formats depending on their personal preference: a standard dichotomus key, a Lucid Phoe-

nix key or a Lucid matrix key. Lucid Phoenix keys are interactive but still dichotomous and a choice needs to be made at each key couplet to continue. Lucid matrix keys, on the other hand, use a different approach where relevant states from multiple character features can be selected independently until identification is achieved. For more information concerning Lucid keys visit http://www.lucidcentral.org. Files are provided in two formats enabling conversion of the Lucid matrix key to other platforms: 1. Lucid Interchange Format version 3 (LIF3) files are XML based files that store all the Lucid3 key data, allowing exchange of the key with other key developers, and 2. SDD files are XML-based files structured using the internationally agreed SDD (Structure of Descriptive Data) Schema. SDD files may be used to exchange Lucid keys with other SDD-compliant applications. Lucid files are published in Appendix 3 of the present paper (doi: 10.3897/zookeys.21.271.app.3.ik).

A third interactive key to Oriental Agathidinae was generated using MX (Yoder et al. 2006-present) and is available at http://purl.oclc.org/NET/oriental-agathidinae. The MX MySQL database files are published in Appendix 4 (doi: 10.3897/zookeys.21.271.app.4.ik). The MX is optimized for viewing in Firefox. MX is an open source, web-based content management tool and workbench for systematists. The images, dynamically generated matrix in Nexus format, and specimen data from the key are available for download. The online key has the utility of dynamically updating from database additions. MX has a wide range of functionality beyond multi-entry and dichotomous key generation, information captured from other activities such as managing specimen data, images, phylogenetic characters, and ontologies may be incorporated into key content. The key to Oriental Agathidinae is dynamically linked to the Hymenoptera Anatomy Ontology (http://hymao.org), which provides a glossary of terminology for the key. More information regarding MX software is found at http://purl.oclc.org/NET/mx-database.

The key data files are published under the conditions of the OpenDataCommons license (ODbl) (http://www.opendatacommons.org/licenses/odbl/1.0/)

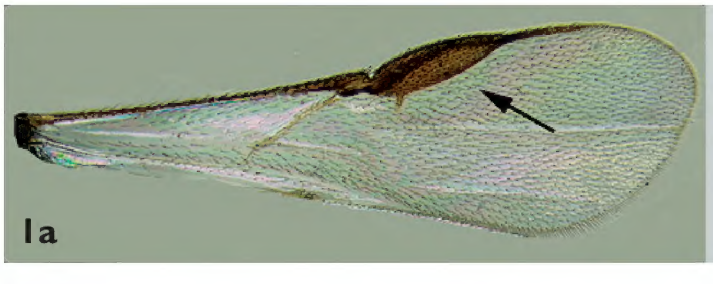
All new species have been registered with Zoobank (Polaszek et al. 2005).

The concept of data publication and dissemination of interacative keys under the open access model is discussed in a forum paper published in the present issue (Penev et al. 2009).

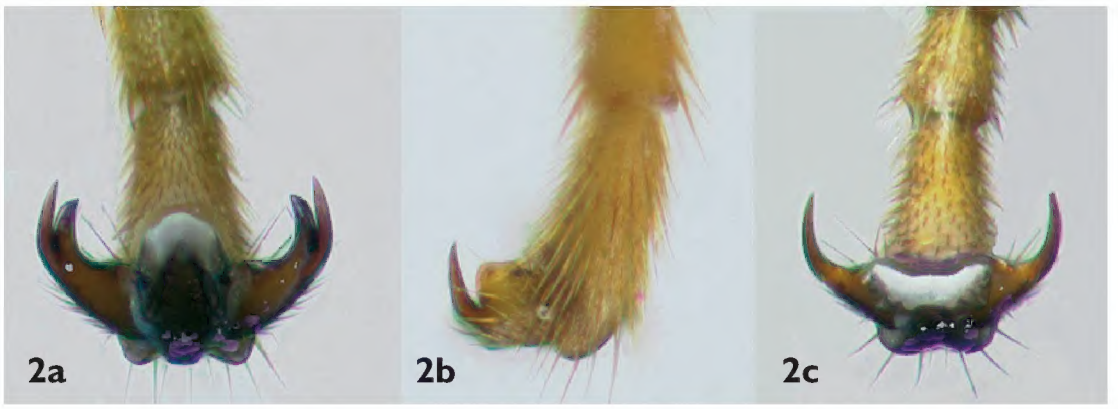
Key to Oriental Genera of Agathidinae

1 – Forewing venation greatly reduced, last abscissa (segment) of RS vein completely absent (1a) ..... ***Aneurobracon*** **Brues, 1930**

– Forewing more complete, last abscissa of RS vein present though sometimes weak (1b) **2**



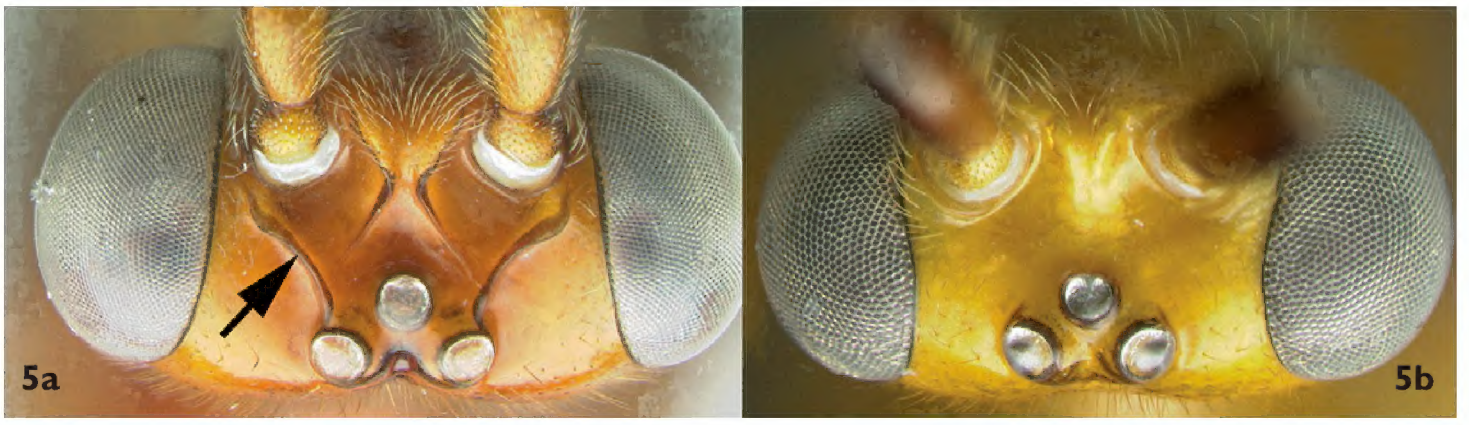
2(1). – Fore and mid claws cleft (2a) **3**
– Fore and mid claws with a basal lobe (2b) **12**
– Fore and mid claws simple (2c) ..... ***Bassus* Fabricius, 1804**



3(2) – Hind trochantellus with one or two distinct carinae (3a)..... **4**
– Hind trochantellus lacking carinae (3b) **7**

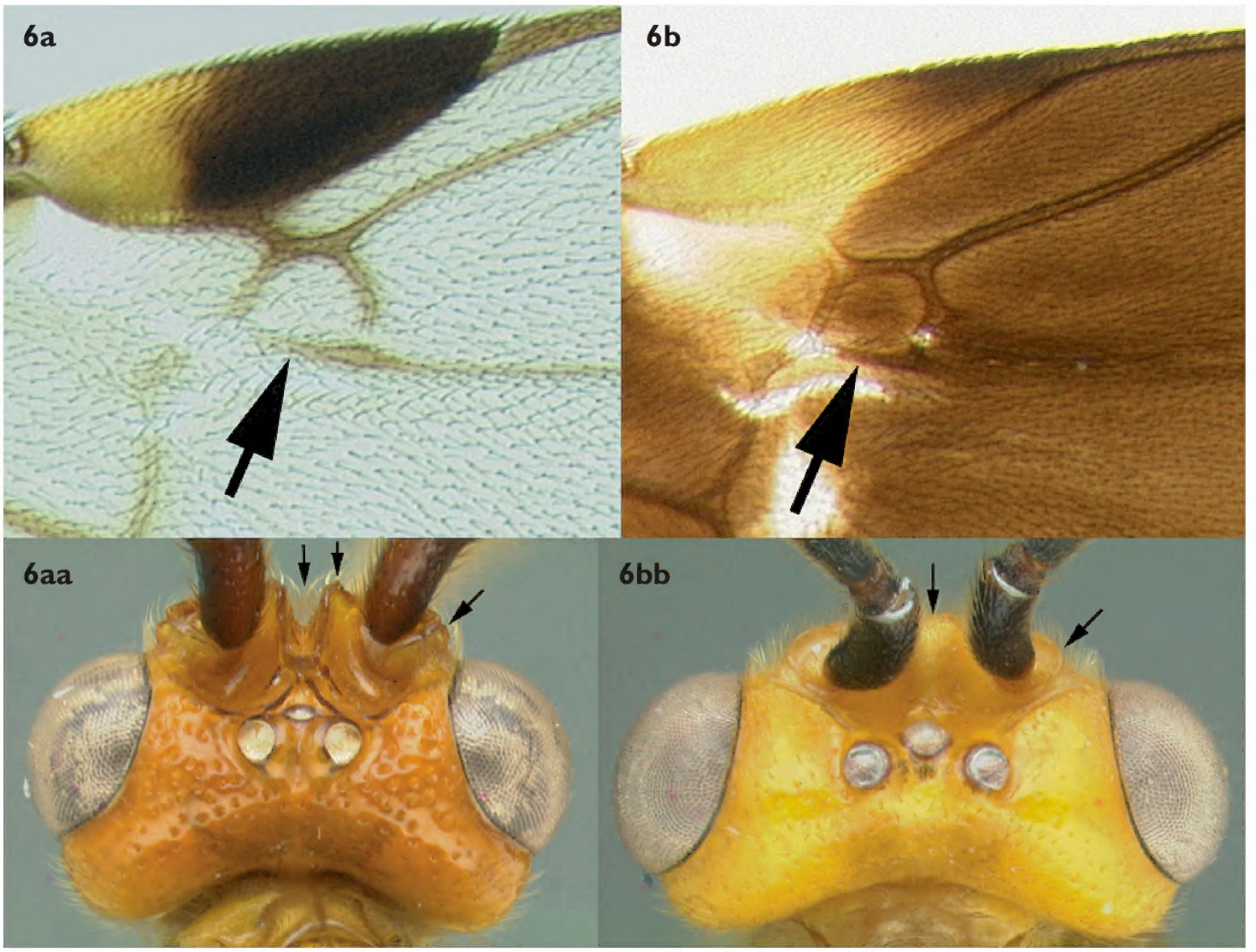
4(3) – Foretibial spurs about as long as basitarsus and ending in a long thin style (4a) ..... ***Coccygidium* Saussure, 1892**
– Foretibial spurs less that 3/4 length of fore basitarsus and ending more abruptly (4b)..... **5**

5(4) – Posterolateral margins of frons bordered with carinae (5a)..... **6**
– Posterolateral margins of frons not bordered with carinae (5b) .....
..... ***Amputostypos* Sharkey, gen. n.**



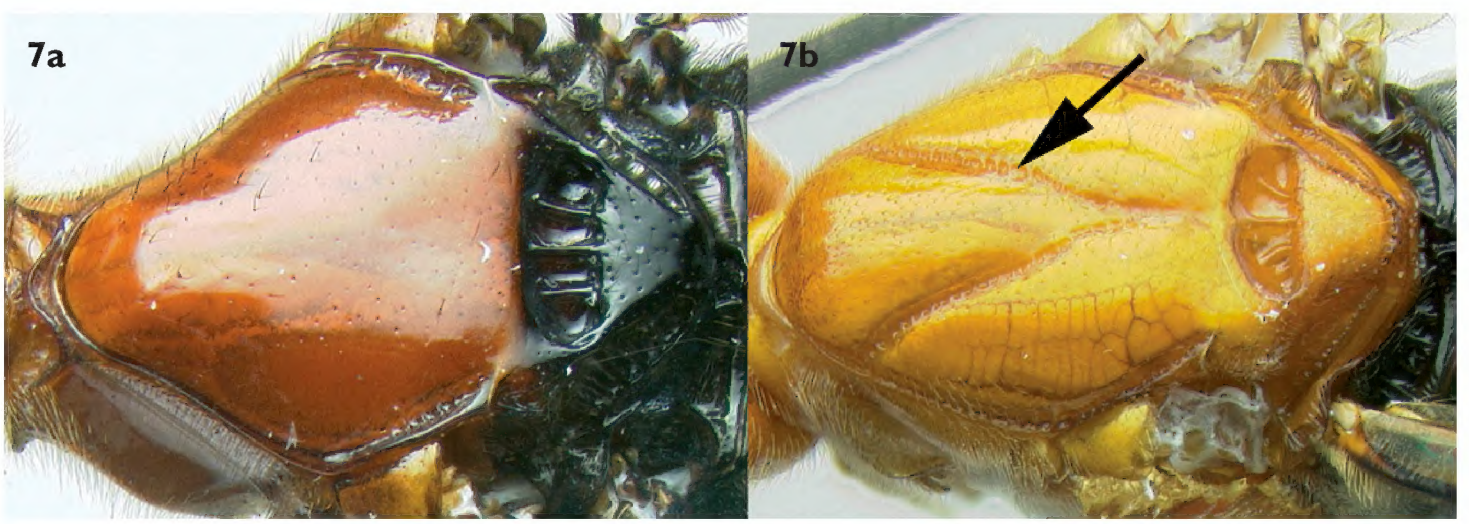
6(5) – 2nd submarginal cell of forewing triangular or at least anterior side distinctly shorter than posterior side (6a); base of antenna surrounded by pronounced medial, posterolateral, and anterior ridges; deep groove between antennae (6aa) ..... ***Hypsostypos*** **Baltazar, 1963**

– 2nd submarginal cell of forewing quadrate, as wide anteriorly as posteriorly (6b); base of antenna surrounded by weak posterolateral, and anterior ridges; lacking deep groove between antennae (6bb) ..... ***Cremnoptoides*** **van Achterberg & Chen, 2004**



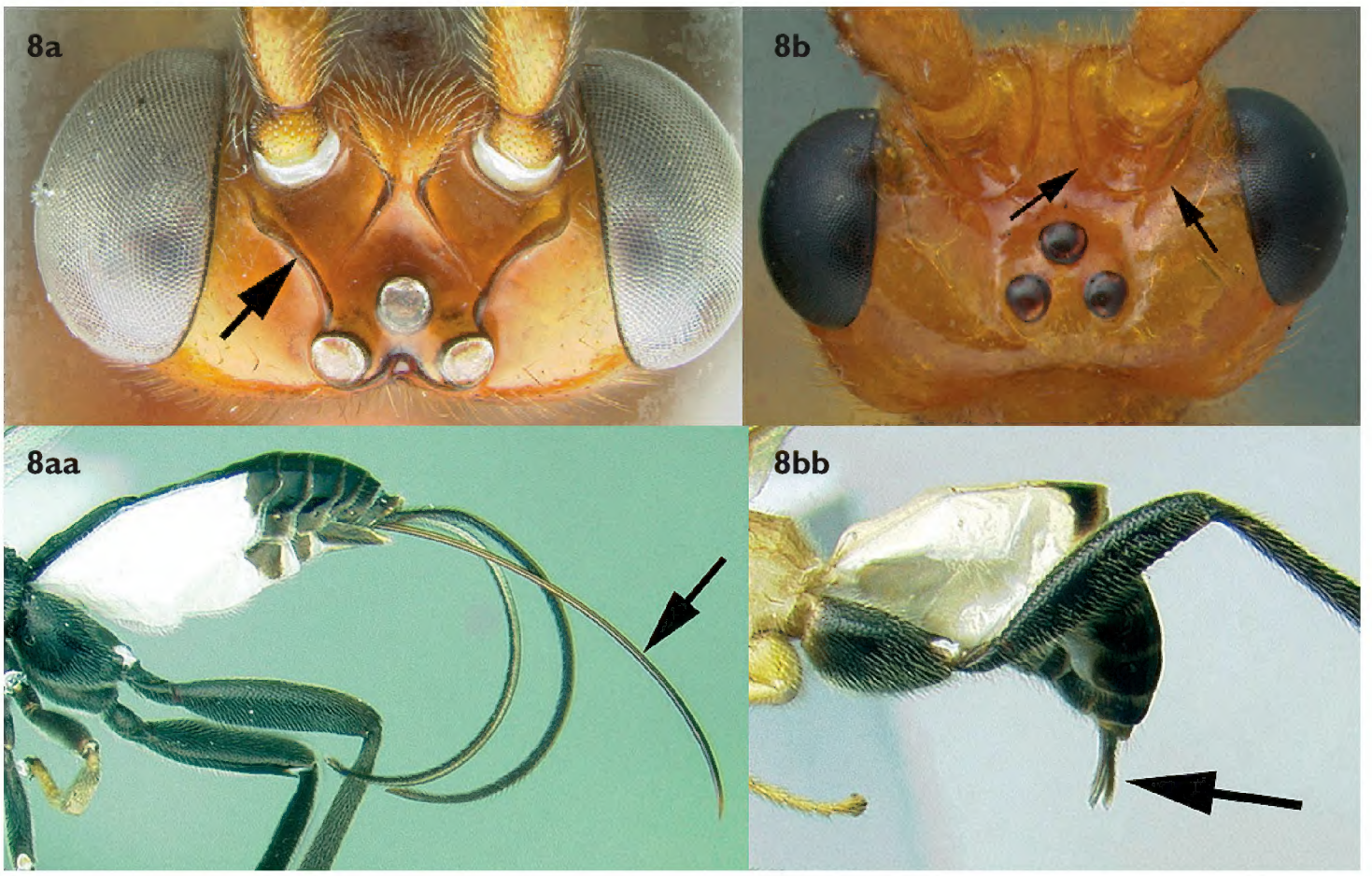
7(3) – Notauli absent (7a) **8**

– Notauli present but not necessarily complete (7b) **9**



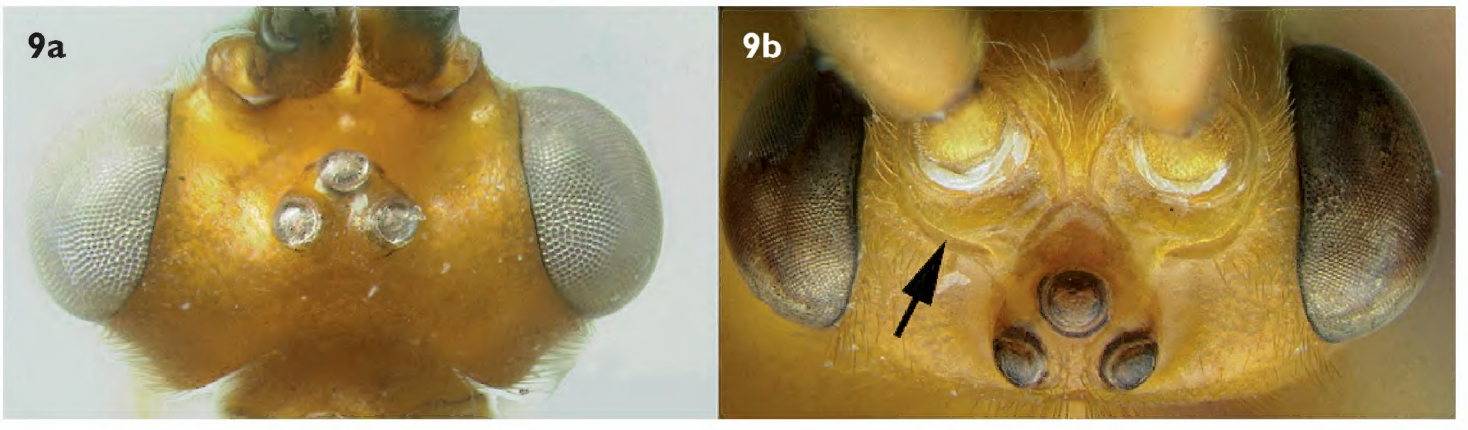
8(7) –Lateral carina of frons directed towards lateral ocellus and not fused with medial carina (8a); ovipositor at least as long as metasoma (8aa) .... ***Biroia* Szépligeti, 1900**

– Lateral carina of frons fused with medial carina forming a circular border around antennal base (8b); ovipositor barely exerted (8bb) .... ***Gyrochus* Enderlein, 1920**

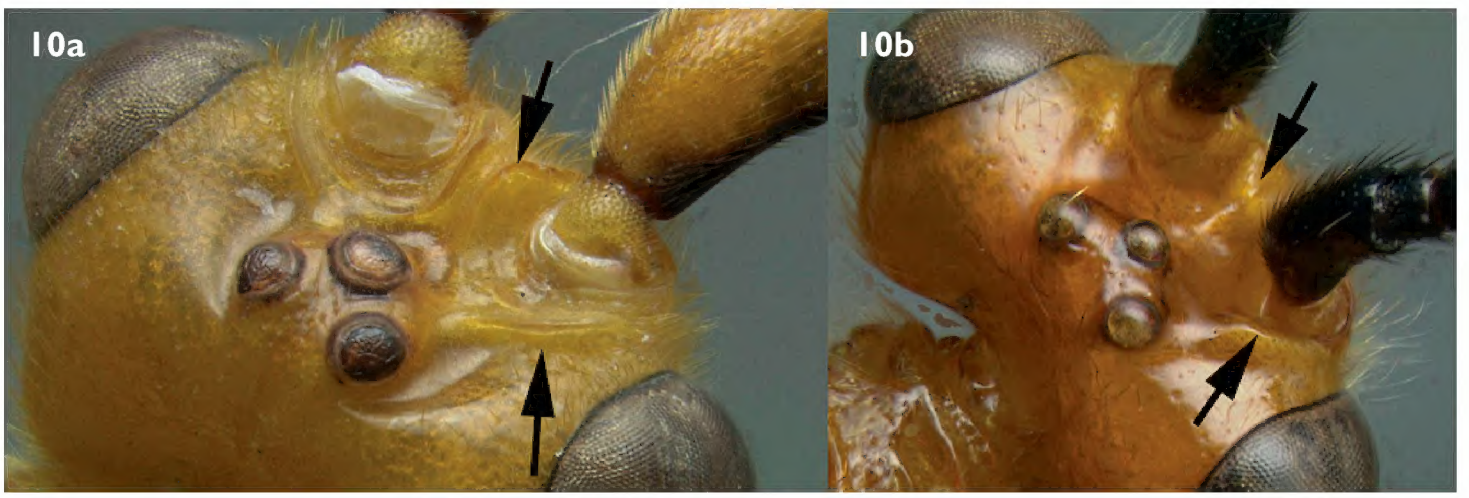


9(7) – Posterolateral margins of frons not bordered with carinae (9a) .... ***Euagathis* Szépligeti, 1900**

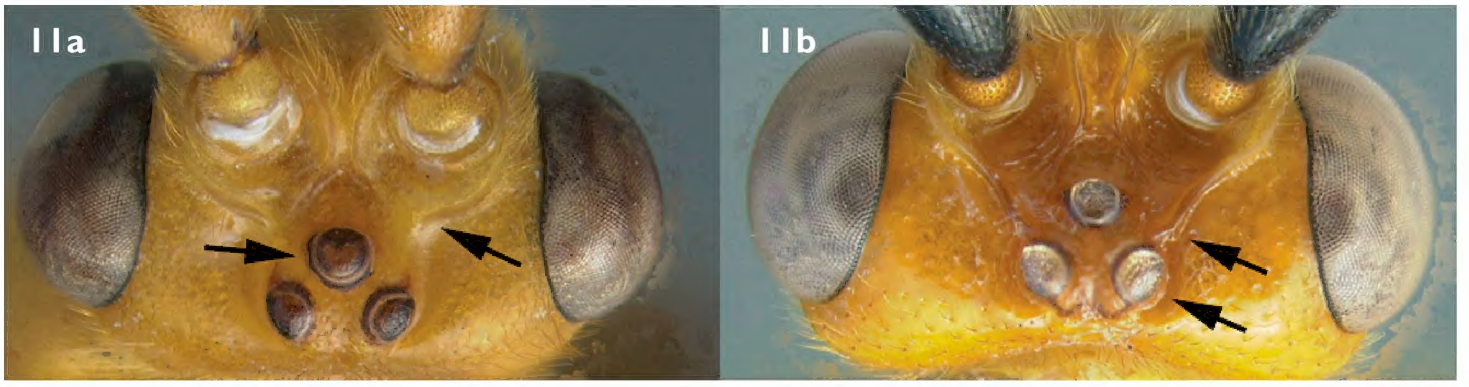
– Posterolateral margins of frons bordered with carinae (9b) **10**



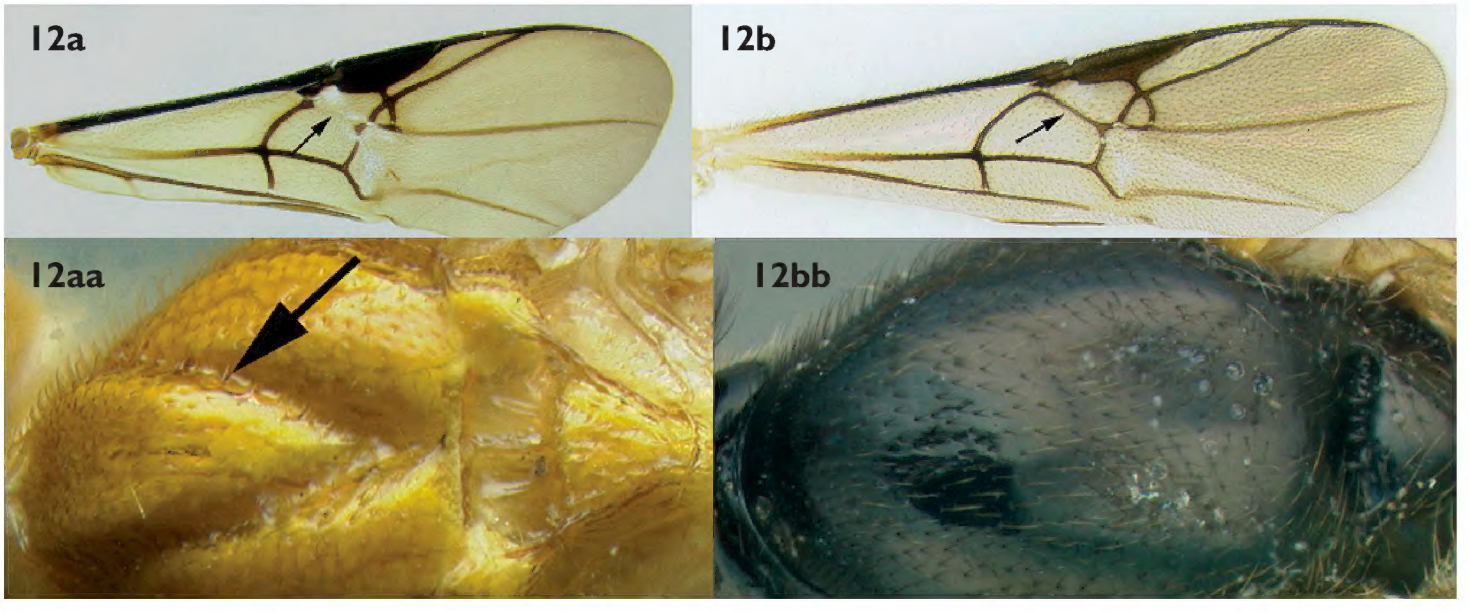
10(9) – Medial and lateral carinae of frons lamellate (high and thin) (10a); ovipositor barely exerted, much shorter than half length of metasoma (see Fig 8bb) . **11**
– Medial and lateral carina of frons in the form of blunt ridges, not lamellate (10b); ovipositor at least as long as the metasoma (see Fig. 8aa) ..... ***Cremnops*** **Förster, 1862**



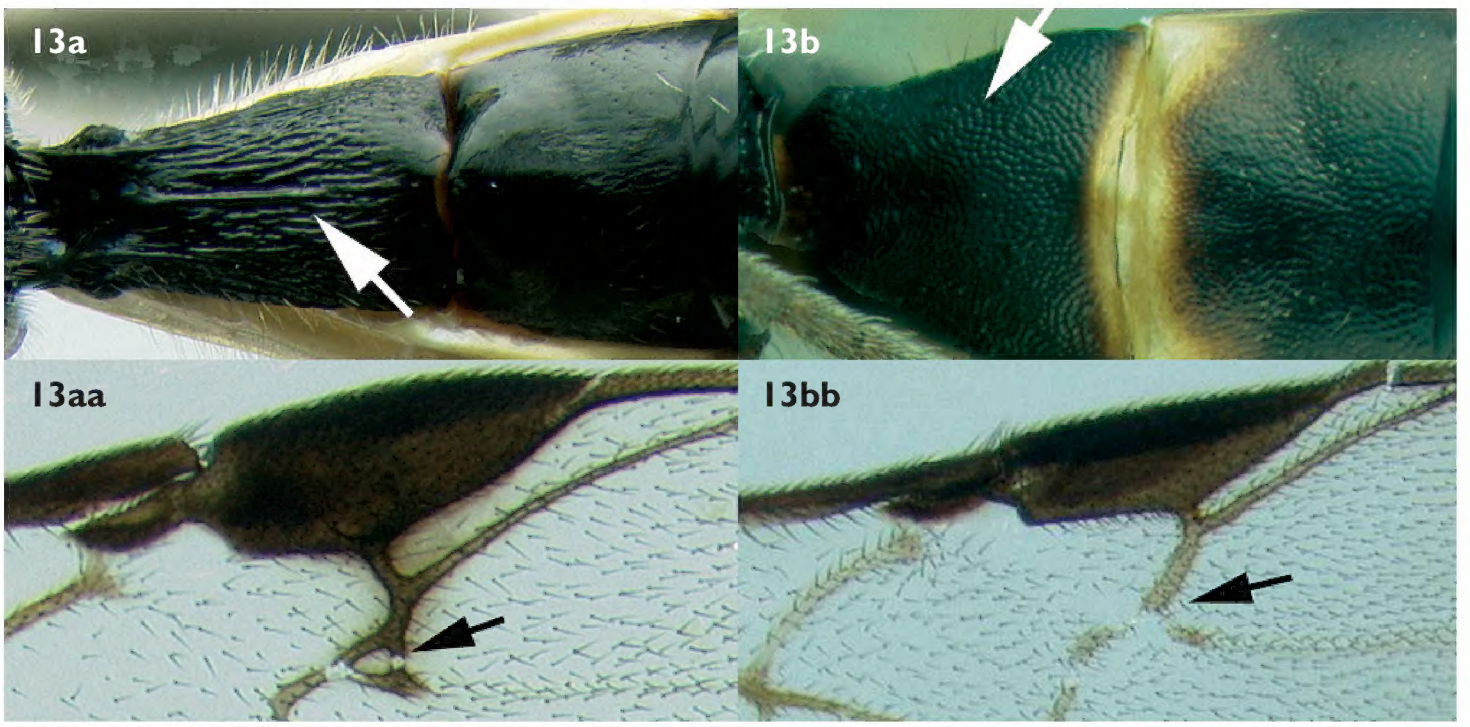
11(10) – Lateral carina of frons with posterior ends directed towards median ocellus (11a) ..... ***Troticus*** **Brullé, 1846**
– Lateral carina of frons with posterior ends directed towards lateral ocelli (11b)..... ***Disophrys*** **Förster**



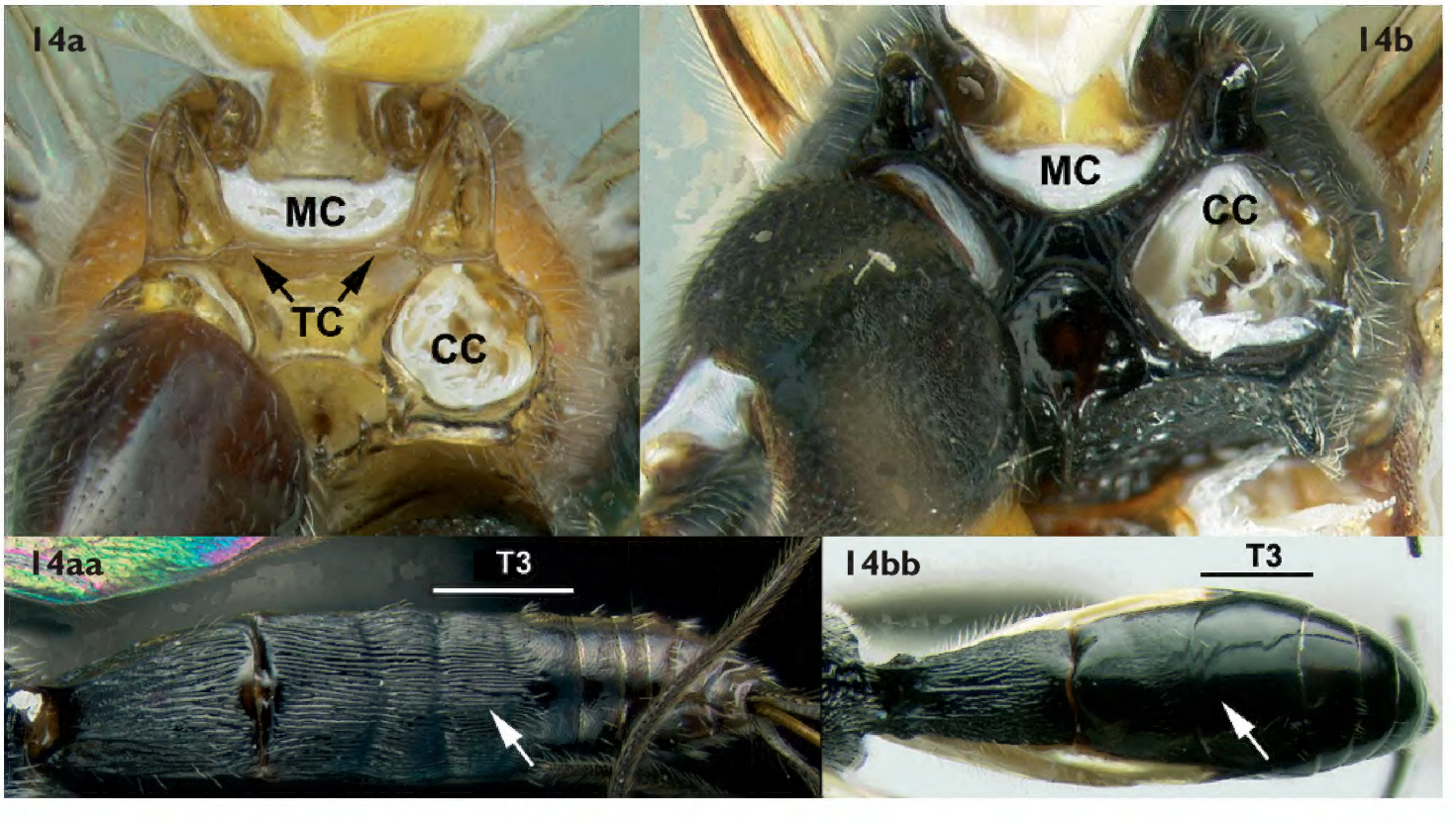
12(2) – RS+M vein of forewing mostly or entirely absent (12a); notauli present but not necessarily complete (12aa) **13**
– RS+M vein of forewing present and complete (12b); notauli absent (12bb) ..... ***Earinus*** **Wesmael, 1837**



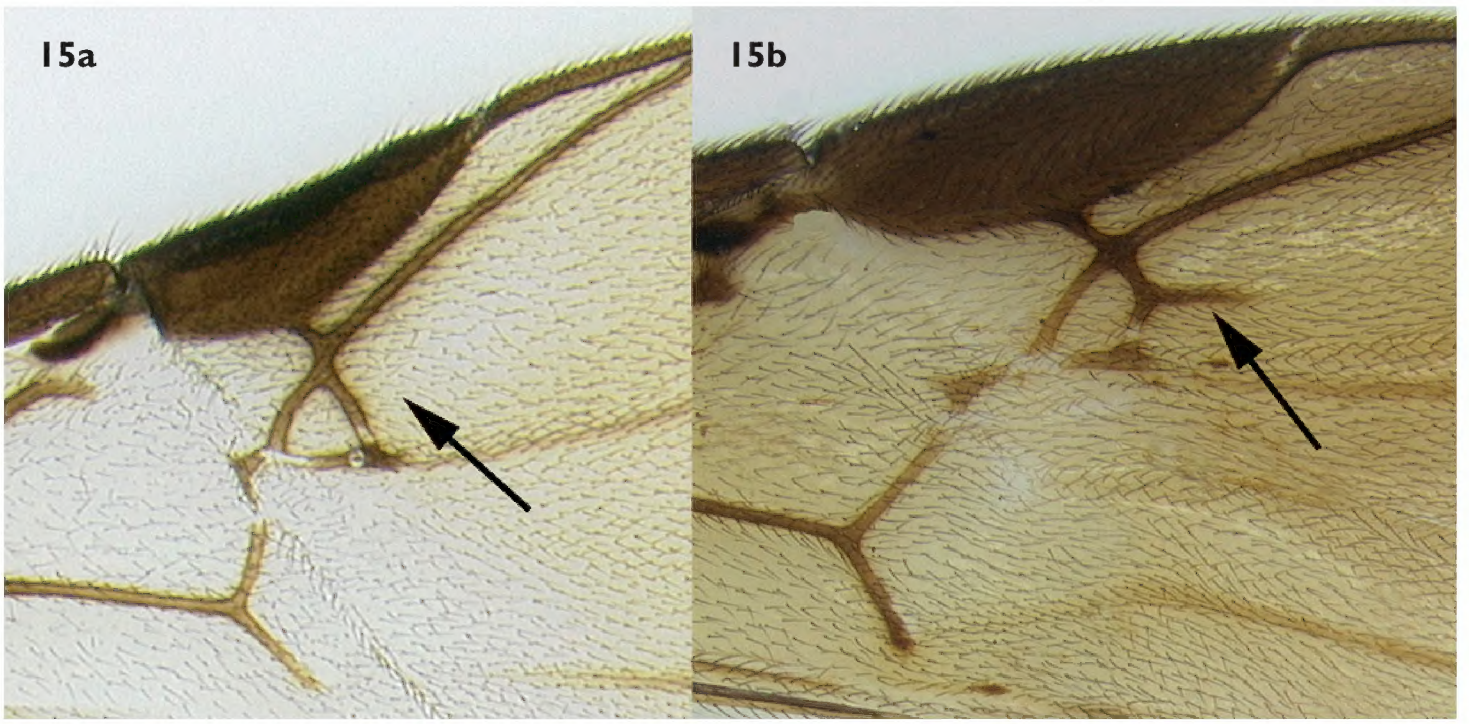
13(12) – First median tergite mostly striate (13a) or (rarely) smooth; 2nd submarginal cell of forewing usually present (13aa)..... **14**
– First median tergite mostly granulate or coriaceous (13b); 2nd submarginal cell of forewing absent (13bb) ..... ***Camptothlipsis* Enderlein, 1920**



14(13) – Metasomal cavity (MC) situated entirely dorsal to coxal cavities (CC) (14a); a wide, high, straight, transverse carinae (TC) present between metasomal cavity (MC) and coxal cavities (CC) (14a); median tergite 3 usually extensively striate in anterior half or more (14aa), sometimes with other sculpture, rarely smooth... **15**
– Metasomal cavity (MC) situated partly between coxal cavities (CC) (14b); wide, high, straight, transverse carinae (TC) between metasomal (MC) and coxal cavities absent, usually curved and relatively shallow if present (14b); median tergite 3 smooth or (rarely) coriarious (14bb) **16**



15(14) – Adventitious vein (2RS) on r-m crossvein of forewing absent or indicated only by slight swelling (15a).....***Lytopylus*** **Förster, 1862**
– Adventitious vein (2RS) on r-m crossvein of forewing present and distinct (15b).....***Braunsia*** **Kriechbaumer, 1894**



16(14) – Mouthparts long, galea significantly longer than wide; gena usually elongate (16a).....***Agathis*** **Latreille, 1804**
– Mouthparts short (normal), galea not longer than wide; gena not elongate (16b).....***Therophilus*** **Wesmael, 1837**

Generic Treatments

Agathis Latreille, 1804

Type species: *Agathis malvacearum* Latreille, 1805.

Cenostomus Förster, 1862, first synonymized by Muesebeck and Walkley (1951) and confirmed by Baltazar (1966), De Santis (1967), Shenefelt (1970), Bhat and Gupta (1977) and Marsh (1979). Type species: *Cenostomus lugubris* Förster, 1862.

Aenigmostomus Ashmead, 1900, first synonymized by Sharkey and Mason (1986) and confirmed by Chou and Sharkey (1989) and Sharkey (1998). Type species: *Microdus longipalpus* Cresson, 1865.

Rhamphagathis Tobias, 1962, synonymized by Sharkey (1998). Type species: *Agathis nasicornis* Telenga, 1955.

Distribution: Holarctic, with more diversity in cool temperate regions. No species of *Agathis* has been collected in Thailand or in the Oriental Region, but the occurrence of the genus in northern high-altitude areas is likely. Bhat and Gupta (1977) reported 45 species of *Agathis* for the Oriental region but they used a different generic concept that included *Bassus* s.s., *Therophilus, and Lytopylus* as they are defined in the present study. None of the species treated by Bhat and Gupta (1977) correspond to *Agathis* s.s., as it is interpreted here.

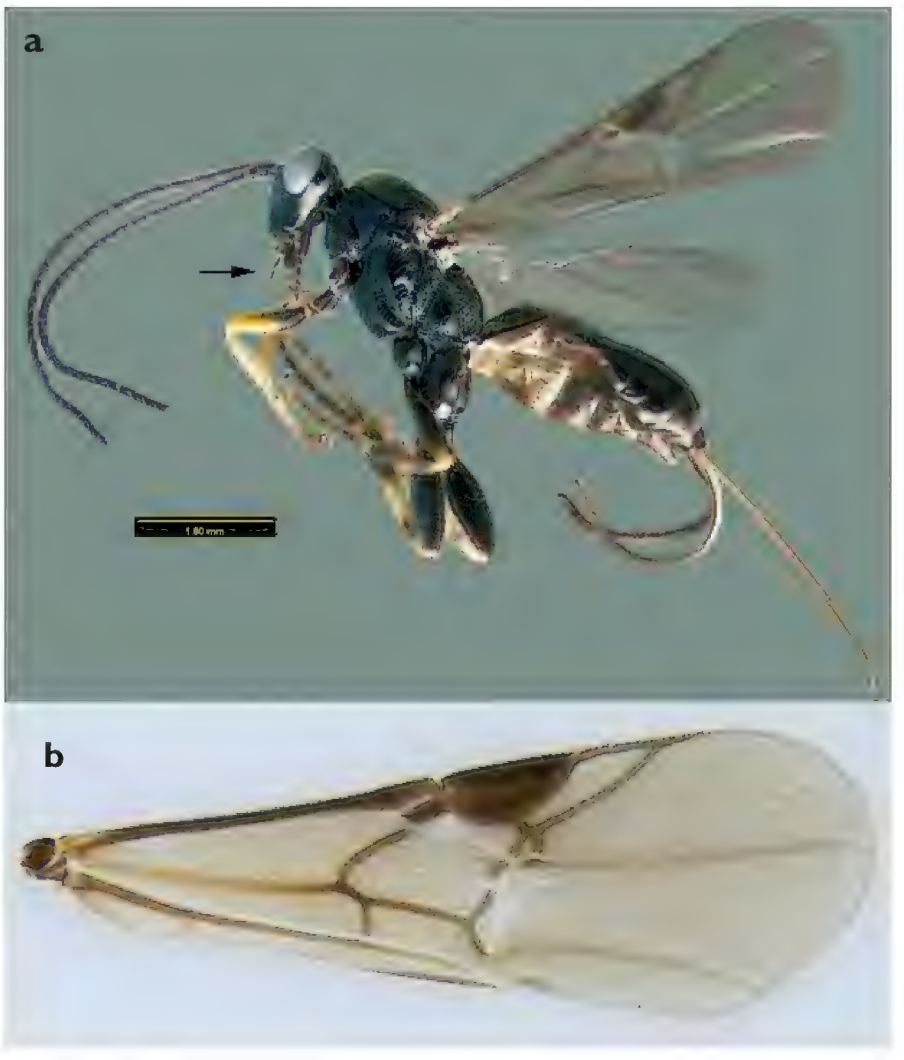


Figure 17. *Agathis* sp. **a** lateral habitus **b** forewing

Diversity: Highly diverse in cool north-temperate climates.

Biology: Species generally attack lepidopterous larvae feeding in flower heads. There are numerous host records many of which are likely to be incorrect; host families that are reasonably certain include: Gelechiidae, Coleophoridae, Oecophoridae, Tortricidae, and Prodoxidae.

Phylogenetic Information. Sister to the clade composed of *Lytopylus* + *Braunsia* (*Lytopylus* corresponds to *Bassus* s.s. in Sharkey et al. 2006).

Diagnosis: Head rostriform or subrostriform (Fig. 17a); tarsal claws not bifid and with a basal lobe (as in Fig. 2b).

Amputostypos **Sharkey, gen. n.**
urn:lsid:zoobank.org:act:83935652-A2F4-4F55-91D3-86BE3DBE7AF4

Type species: *Disophrys concolor* Szépligeti, 1908.
Lectotype of *D. concolor* designated by van Achterberg, 1974.
Amputostypos concolor **comb. n.**

Etymology: From the Greek words *Amputo* and *stypos*, meaning short and stem respectively. These refer to the close relationship with the genus *Hypsostypos*, meaning high stem. *Amputostypos* differs from *Hypsostypos* primarily in lacking high ridges surrounding the antennal bases.

Taxonomy: Sharkey et al. (2006) included this generic concept under *Hypsostypos*, mistakenly thinking that the type species of *Hypsostypos* lacked posterolateral carinae on the frons.

Distribution: Oriental, East Palaearctic, Oceanic, Australian, African (rare), primarily tropical and warm-temperate, but reasonably represented in moderate temperate localities. No specimens are recorded from Thailand but we have collected 83 specimens representing 10 species.

Diversity: It is difficult to estimate the number of species due to recent changes in generic concepts. Sharkey et al. (2006) divided *Coccygidium* s.l. into *Hypsostypos*, *Zelomorpha*, and *Coccygidium* s.s., however few new combinations were made. Members of *Amputostypos* are restricted to the Old World and there are about 12 species recorded for the Oriental region. Bhat and Gupta (1977) included 10 species. *Amputostylos* corresponds to what they referred to as the Sulana species group of *Zelomorpha*.

Biology: There are no reliable host records available. The short ovipositor suggests that they attack exposed hosts. Many species are pale colored with rather large ocelli and presumably nocturnal.

Phylogenetic Information: Probable sister to *Euagathis* (Sharkey et al. 2006).

Diagnosis: Members are very similar to *Coccygidium* and *Euagathis*. Unlike *Coccygidium* they have relatively short foretibial spurs (Fig. 4b) and the frons lacks lateral carinae (Fig.5b). Unlike *Euagathis* they have one or two carinae ventrally on the hind trochantellus (Fig. 3a). Members differ from *Hypsostypos* in lacking the high ridges surrounding the antennal insertions.

Description: Head: Lateral carina of frons lacking (Fig. 5b); interantennal space usually with two weak prominences separated by shallow groove (never high as in *Hypsostypos*); gena not extended ventroposteriorly into sharp prominence; labial palp with four segments, third segment not reduced, more than half length of apical segment; apical antennomere acute. **Mesosoma:** Mesoscutum with sculptured notauli; posteroscutellar depression absent; median areola of metanotum surrounded by well defined carinae laterally and posteriorly; propodeum areolate carinate; posterolateral corners of propodeum elongate; propleuron mildly convex to flat; propodeal pseudosternite well developed, separating hind coxal cavities from metasomal foramen. **Legs**: Foretibial spur not elongate, about ½ length of basitarsus (Fig. 4b); foretibial spur with setae extending to its apex or nearly so (Fig. 4b); foretibia lacking pegs; tarsal claws bifid (Fig. 2a); midtibia with apical pegs but lacking pegs at midlength; hind femur usually rugose ventrally; hind tibia with 2 apical pegs, posterior peg larger than anterior peg. **Wings** (Fig. 18b): Rs+Ma vein of forewing incomplete and not tubular throughout; second submarginal cell of forewing triangular and sessile; forewing 3RSb straight to slightly sinuate; hind wing crossvein r absent; hind wing crossvein r-m weakly indicated as a short nebulous or spectral thickening, i.e., as a depressed line that may or may not be pigmented, near the base of Rs; hind wing Cub present as nebulous or spectral vein. **Metasoma**: All terga smooth, lacking sculpture; median tergite 1 lacking pair of longitudinal carinae;

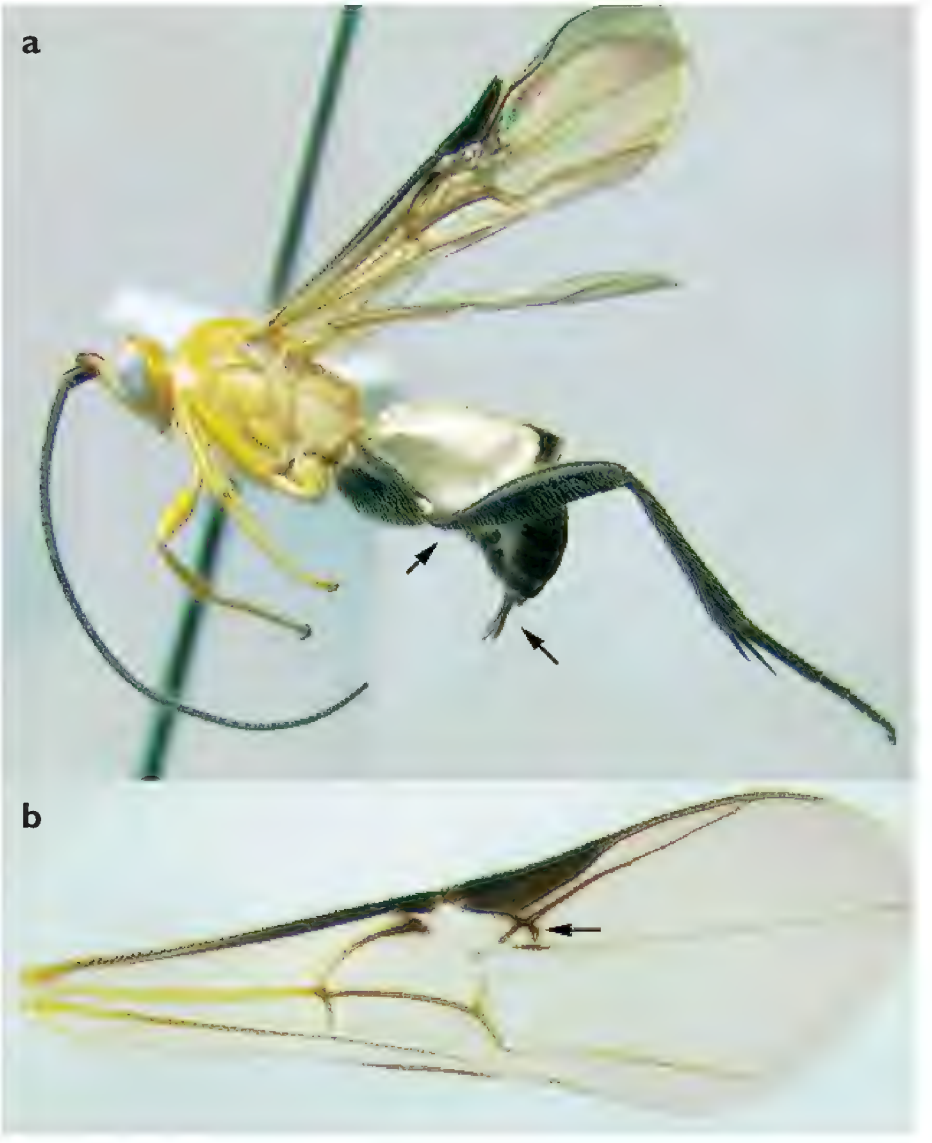


Figure 18. *Amputostypos* sp. **a** lateral habitus **b** forewing

median syntergum 2+3 lacking transverse depression separating terga 2 and 3 or with depression barely indicated; ovipositor, decurved, shorter than half the length of the metasoma when fully extended (Fig. 18a).

Aneurobracon Brues, 1930

Type species: *Aneurobracon bequaerti* Brues, 1930.

Distribution: Oriental, East Palaearctic, Oceanic, Australian, tropical to warm-temperate.

Diversity: Five species described world-wide, two recorded for the Oriental region (India, Philippines), and none for Thailand. No specimens of *Aneurobracon* have been collected in Thailand but it is likely that this rare genus occurs in the country.

Biology: There are two host records both on members of the family Gracillariidae.

Phylogenetic Information: Sister to *Mesocoelus*, which is confined to the neotropics.

Diagnosis: The lack of venation (Fig. 19b), long legs and long setae on the hind tibia (Fig.19a) are all unique for the Oriental agathidine fauna.

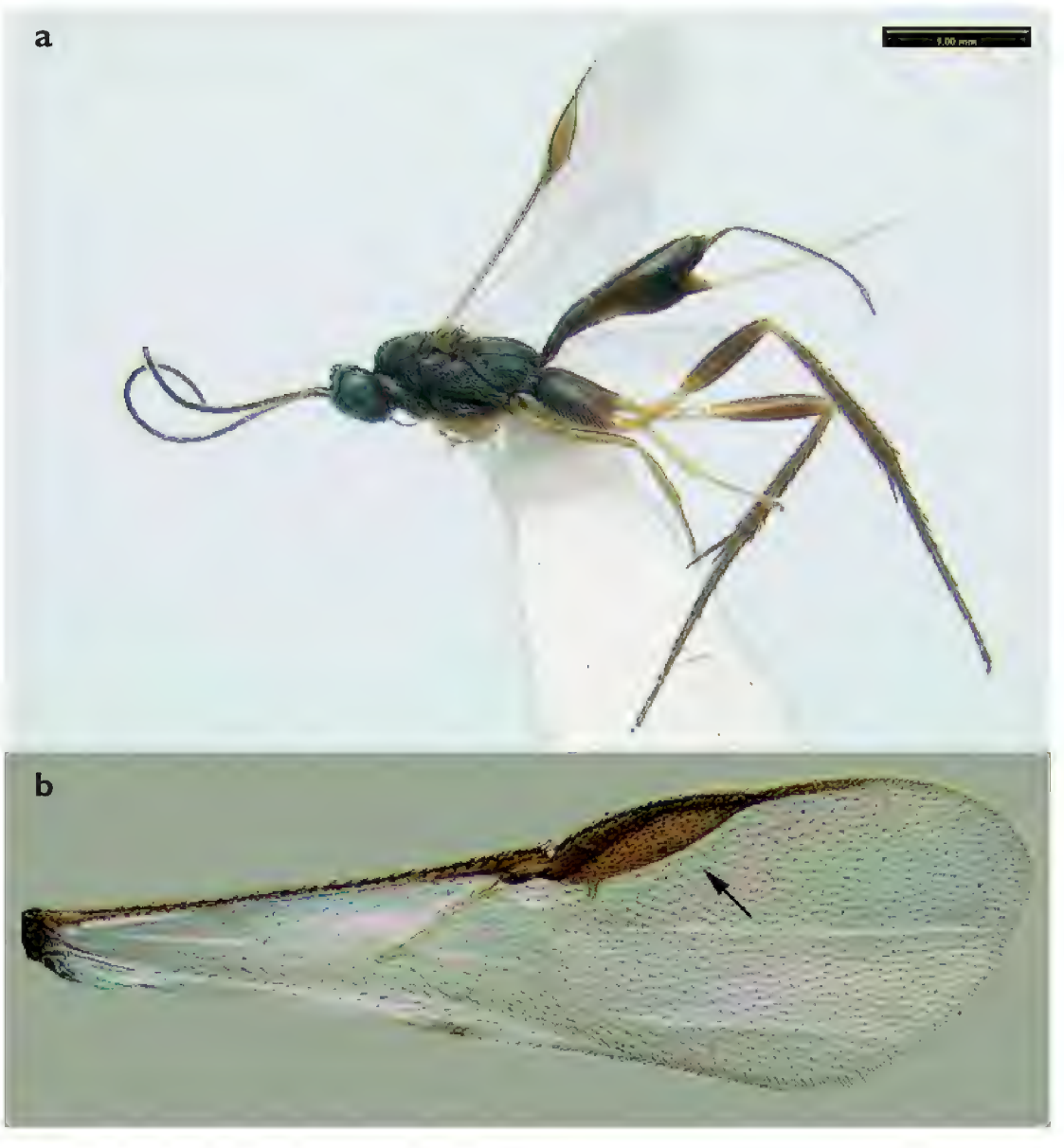


Figure 19. *Aneurobracon* sp. **a** lateral habitus **b** forewing

Biroia Szépligeti 1900

Type species: *Biroia elegans* Szépligeti, 1900.
Isoptronotum Enderlein, 1920, synonymized by Sharkey et al. (2006). Type species: *Isoptronotum taeniocauda* Enderlein, 1920.

Distribution: Old world tropical, including African, Oriental, and Australian regions. Bhat and Gupta (1977) used the name *Isoptronotum* for the same concept, and it here considered a junior synonym (following Sharkey et al. 2006). Bhat and Gupta (1977) included 10 species (of the present concept of *Biroia*) in the Oriental Region. No specimens have been recorded from Thailand but we have collected one or two species; that is, one polymorphic species or two closely related species.

Diversity: 29 species are known of which 12 are recorded from the Oriental region.

Biology: Unknown, the long ovipositors suggest concealed hosts.

Phylogenetic Information. Sister to *Zacremnops*, a small genus with a Neotropical distribution (Sharkey et al. 2006).

Taxonomic Information. Most authors treated species under *Isoptronotum* prior to Sharkey et al. (2006).

Diagnosis: Mesoscutum smooth, lacking notauli (Fig.7a); fore and mid claws bifid (Fig. 2a), lateral carina of frons lamellate (high and thin) (Fig. 8a); ovipositor more than half length of metasoma (Fig.20a).

Figure 20. *Biroia* sp. **a** lateral habitus **b** forewing

Braunsia Kriechbaumer, 1894

Type species: *Braunsia bicolor* Kriechbaumer, 1894.

Metriosoma Szépligeti, 1902, synonymized by Sharkey et al. (2006). Type species: *Metriosoma munda* Szépligeti, 1902.

Lissagathis Cameron, 1911, synonymized by Sharkey et al. (2006). Type species: *Lissagathis bicarinata* Cameron, 1911.

Laccagathis Watanabe, 1934, synonymized by Sharkey et al. (2006). Type species: *Laccagathis formosana* Watanabe, 1934.

Pholeocephala van Achterberg, 1988, synonymized by Sharkey et al. (2006). Type species: *Pholeocephala lieftincki* van Achterberg, 1988.

Distribution: Old world tropical, including African, Oriental, and Australian regions. Bhat and Gupta (1977) separated the genus *Laccagathis*, which is here considered a junior synonym (following Sharkey et al. 2006). No specimens are recorded from Thailand, but we have collected two species.

Diversity: 68 species are described world-wide and 26 are known from the Oriental region (Yu et. al. 2005).

Biology: Most host records are on Pyralidae, with one record each for Lasiocampidae and Noctuidae that need confirmation.

Phylogenetic Information. Sister to *Lytopylus* (as *Bassus* s.s. in Sharkey et al. 2006).

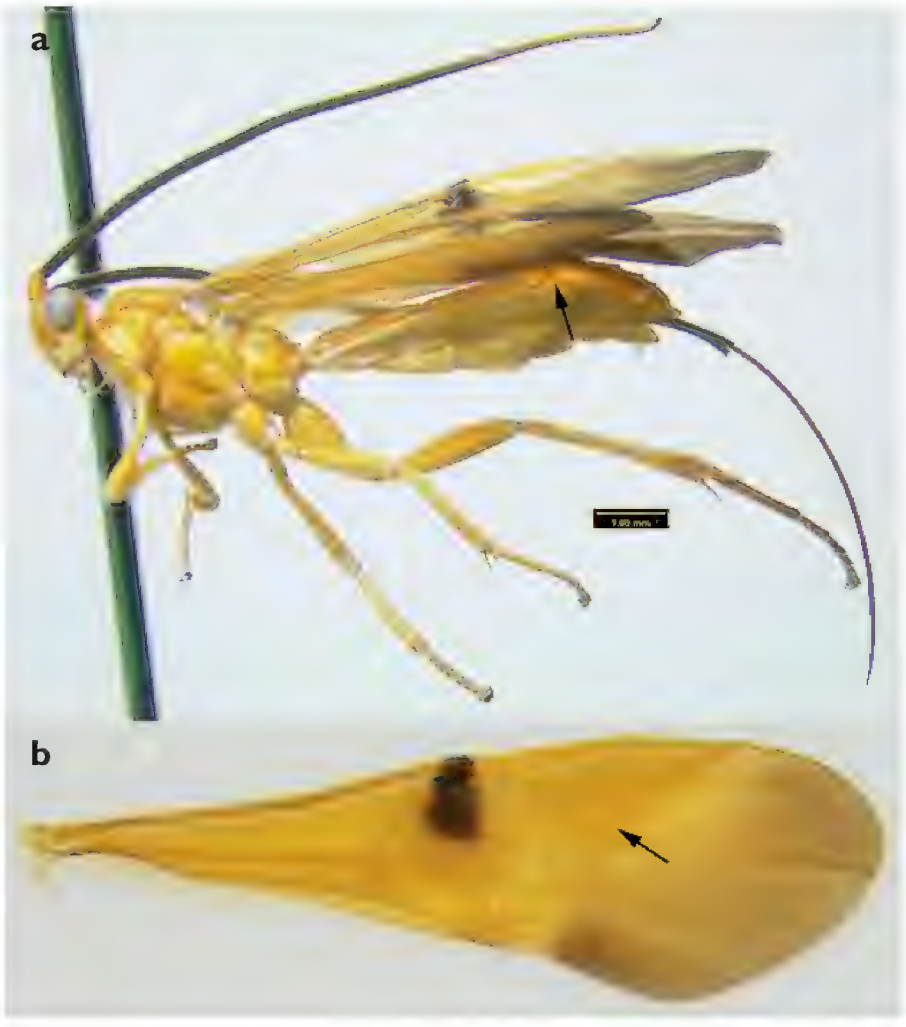


Figure 21. *Braunsia* sp. **a** lateral habitus **b** forewing

Diagnosis: Metasomal median tergite 3 with longitudinal striae (as in Fig. 14a), first median tergite with prominent lateral longitudinal carinae; second submarginal cell with an adventitious 2RS vein (Figs. 15b, 21b).

Camptothlipsis Enderlein, 1920

Type species: *Camptothlipsis costalis* Enderlein, 1920.

Distribution: Old World, including Palaearctic, African, Oriental, and Australian regions; far more diverse in tropical areas. Related taxa occur in the New World and continued research will determine whether or not these should be considered congeneric. Often included with *Bassus* s.l. in keys.

Diversity: 17 species have been described, 6 from the Oriental region all of which were included by Bhat and Gupta (1977). No specimens have been recorded from Thailand but we have collected two species. The genus is especially diverse in the Ethiopian region where there are more than 100, mostly undescribed, species.

Biology: The three host records are all on Gelechiidae.

Phylogenetic Information. In a clade that includes *Zacremnops, Plesiocoelus* and some taxa presently placed in the polyphyletic *Therophilus* (as *Bassus* s.l. in Sharkey et al. 2006).

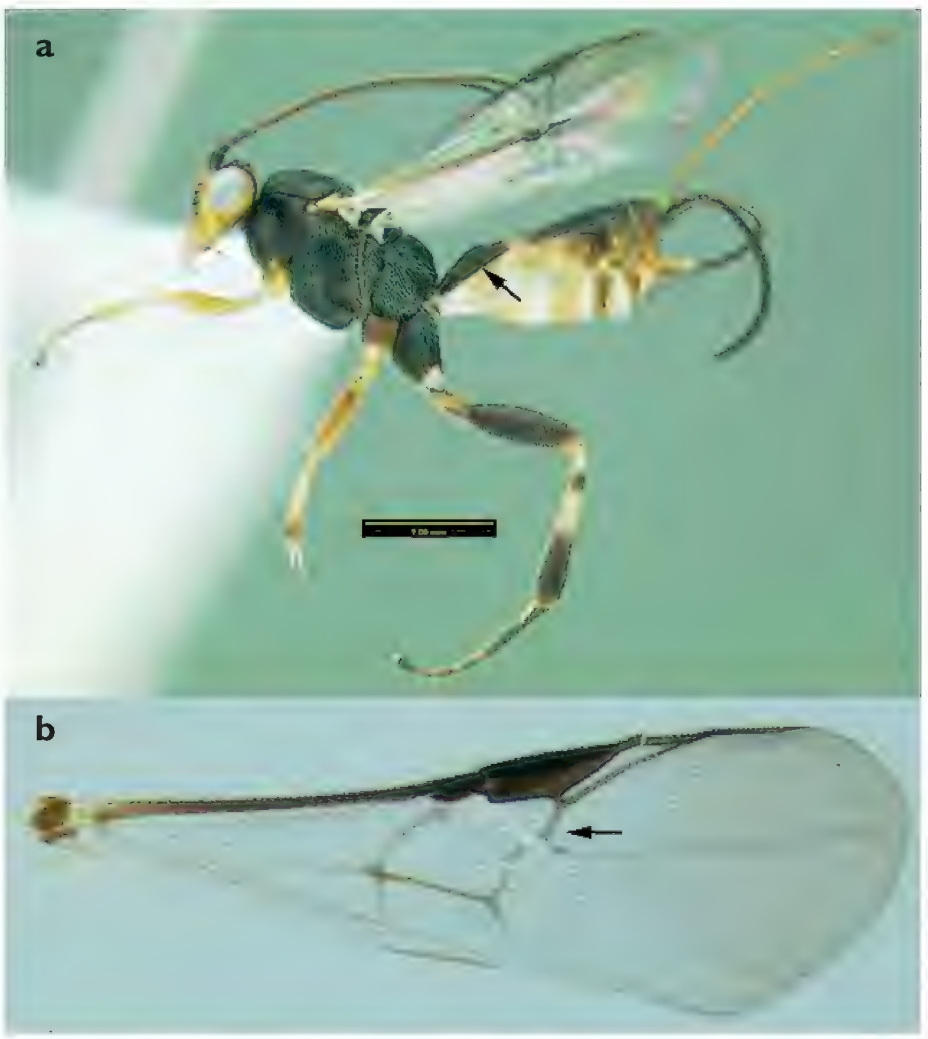


Figure 22. *Camptothlipsis* sp. **a** lateral habitus **b** forewing

Taxonomic Information. Treated as a synonym of *Bassus* in many recent publications, e.g., Simbolotti and van Achterberg (1992), Papp (1998).

Diagnosis: Second submarginal cell absent (Fig. 22a); median tergite 1 coriaceous or granulate (Fig. 13b).

Coccygidium Saussure, 1892

Type species: *Coccygidium luteum* Saussure, 1892.

Brachyropalum Kriechbaumer, 1894, first synonymized by Chou and Sharkey (1989) and confirmed by Sharkey (1996) and Sarmiento and Sharkey (2005). Type species: *Brachyropalum pallidum* Kriechbaumer, 1894.

Brachyrhopalum Dalla Torre, 1898, synonymized by Chou and Sharkey (1989). Emendation for *Brachyropalum.*

Neophylax Ashmead, 1900, first synonymized by Chou and Sharkey (1989) and confirmed by Sharkey (1996) and Sarmiento and Sharkey (2005). Type species: *Neophylax snyderi* Ashmead, 1900.

Ahngeria Kokujev, 1902, first synonymized by van Achterberg and Maeto (1990) and confirmed by Sharkey (1996, 1998) and Sarmiento and Sharkey (2005). Type species: *Ahngeria transcaspica* Kokujev, 1902.

Lisitheria Cameron, 1904, first synonymized by Chou and Sharkey (1989) and confirmed by Sharkey (1996); Sarmiento and Sharkey (2005). Type species: *Lisitheria nigricornis* Cameron, 1904.

Xanthomicrodus Cameron, 1904, first synonymized by Chou and Sharkey (1989) and confirmed by Sharkey (1996) and Sarmiento and Sharkey (2005). Type species: *Xanthomicrodus iridipennis* Cameron, 1904.

Caenophylax Schulz, 1911, first synonymized by Chou and Sharkey (1989) and confirmed by Sharkey (1996) and Sarmiento and Sharkey (2005). New name for primary homonym *Neophylax* Ashmead, 1900, nec *Neophylax* McLachlan, 1871.

Distribution: Oriental, Palaearctic, Oceanic, Australian, African, primarily tropical and warm-temperate, but reasonably represented in moderate temperate localities. No species are recorded from Thailand but we have collected 18 specimens representing 3 or 4 species in Thailand.

Diversity: It is difficult to estimate the number of species due to recent changes in generic concepts. Sharkey et al. (2007) divided *Coccygidium* s.l. into *Hypsostypos*, *Zelomorpha*, and *Coccygidium* s.s., but did not include a list of new combinations so the generic concepts have not been incorporated into the Taxapad database (Yu et al. 2005). Members of *Coccygidium* are restricted to the Old World and there are about 10 species recorded for the Oriental region; Bhat and Gupta (1977) included 8 species. *Coccygidium* corresponds to what they referred to as the Fuliginosa species group of *Zelomorpha*.

Biology: There are five host records, all on members of the family Noctuidae. Many species are pale colored with rather large ocelli and are nocturnal. The short ovipositor suggests that they are attacking exposed hosts.

Phylogenetic Information. Sister to *Zelomorpha* which is New World and primarily tropical in distribution (Sharkey et al. 2006).

Taxonomic Information. Chou and Sharkey (1989) treated *Zelomorpha* as a junior synonym; however the monophyly of both *Coccygidium* and *Zelomorpha* were confirmed by Sharkey et al. (2006).

Diagnosis: The long, style-like, foretibial spur (Fig. 4a) is unique amongst Agathidinae. Members are otherwise very similar to those of *Amputostypos*, which are more commonly collected in Malaise traps in the Oriental Region.

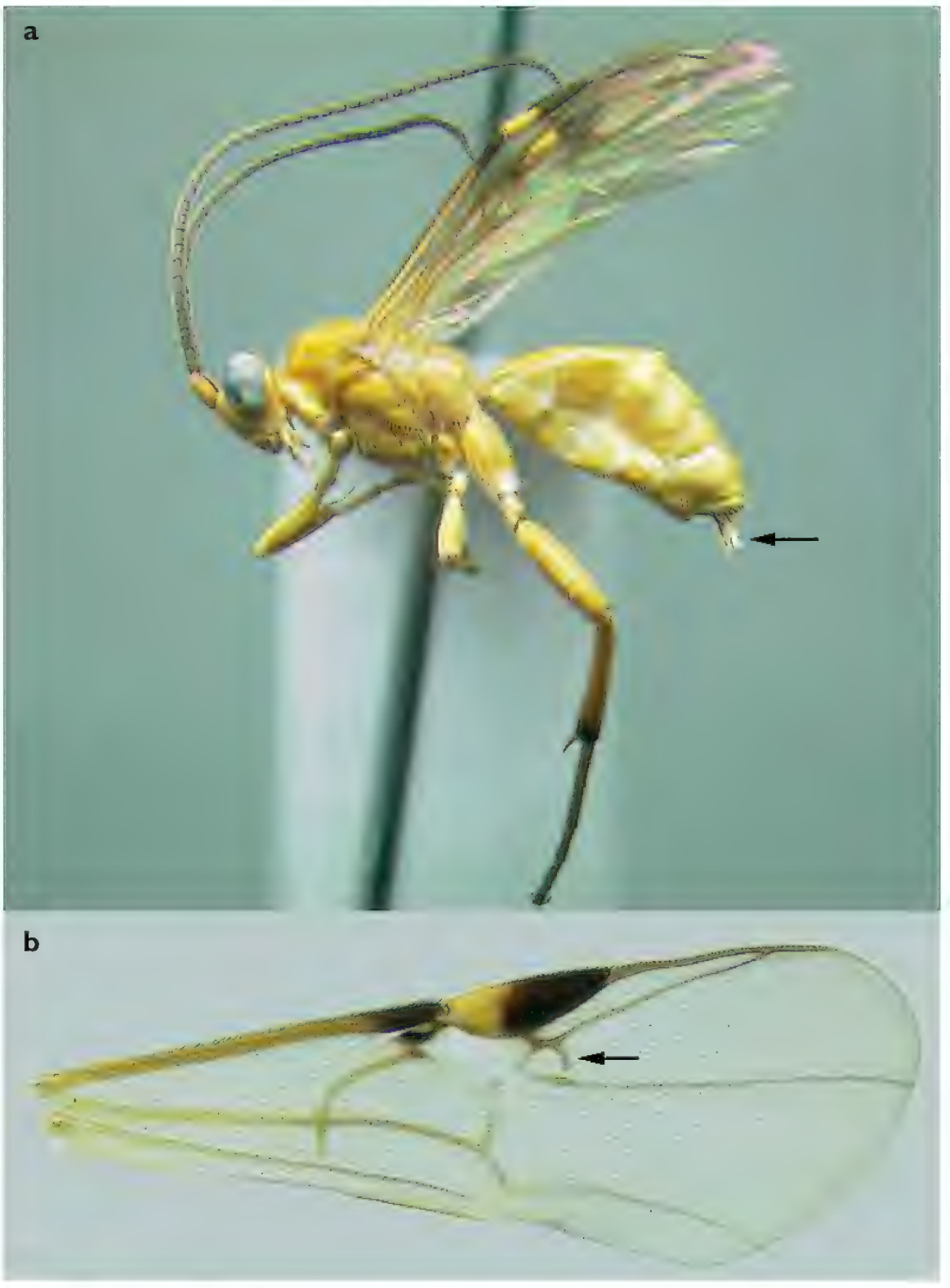


Figure 23. *Coccygidium* sp. **a** lateral habitus **b** forewing

Cremnops Foester, 1862

Type species: *Bracon deflagrator* Spinola, 1808.

Distribution: Cosmopolitan, with similar representation in tropical and temperate habitats. No specimens are recorded from Thailand but we have collected one or two species represented by less than 10 specimens. They are similar to the widespread Palaearctic species *C. desertor*, and may be conspecific.

Diversity: 73 species described world-wide, 16 recorded for the Oriental region (all treated by Bhat 1979).

Biology: Host families include Pyralidae (10 spp.), Noctuidae (4 spp.), Tortricidae (2 spp.) Sesiidae (1 sp.). The relatively long ovipositor suggests that members attack concealed hosts. The coloration of the Oriental species indicates that they are diurnal, however nocturnal species are known from other areas.

Phylogenetic Information. Sister to *Cremnoptoides* (unpublished, based on COI and 28S sequence data).

Diagnosis: Ovipositor longer than half length of metasoma (Fig. 24a); fore and mid tarsal claws cleft (Fig.2a); notauli impressed (as in Fig. 7b); hind trochantellus lacking ventral carinae (as in Fig. 3b).

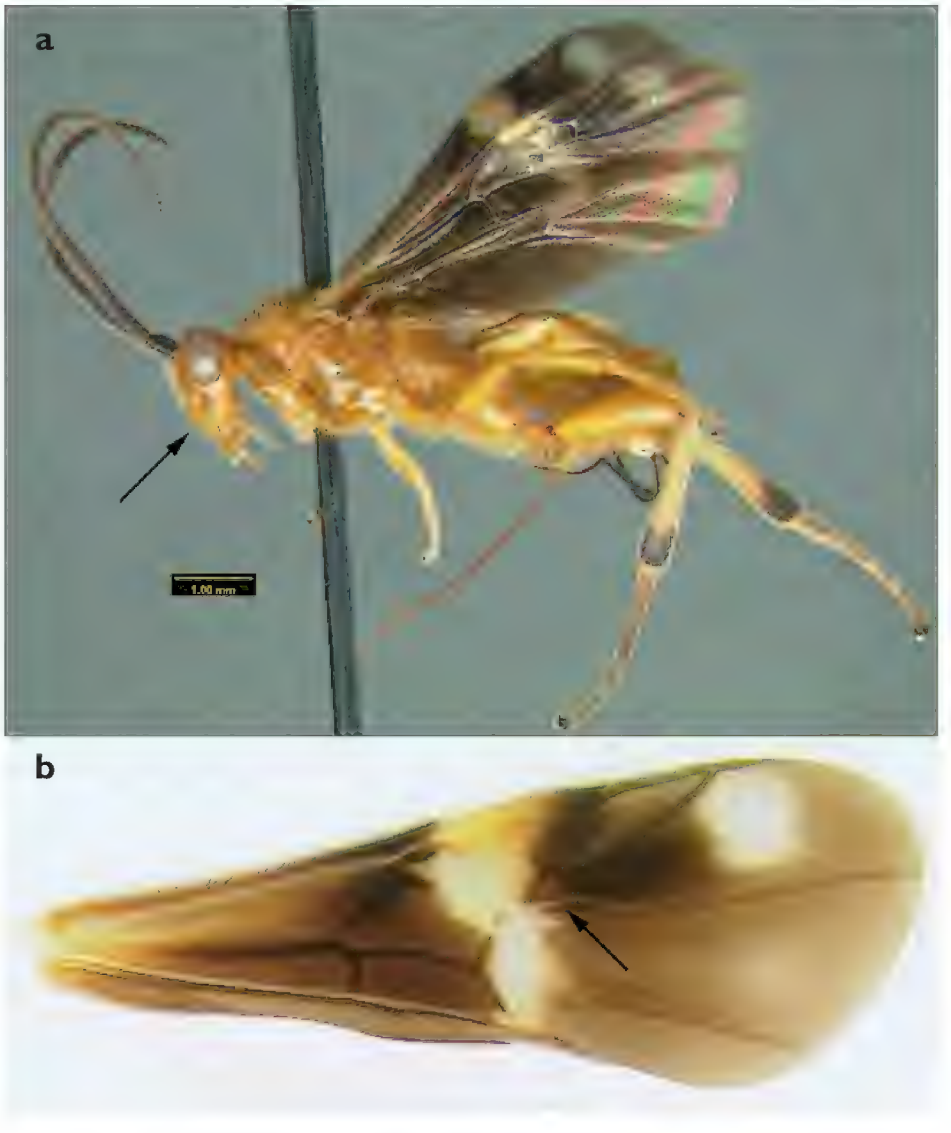


Figure 24. *Cremnops* sp. **a** lateral habitus **b** forewing

Cremnoptoides van Achterberg & Chen, 2004

Type species: *Cremnops pappi* Sharkey, 1996.

Distribution and **Diversity:** Only represented in the literature by two species from Japan and Korea (Sharkey 1996) and China (Henan) (van Achterberg & Chen 2004). We have five specimens representing a new species from Thailand.

Biology: Unknown; the long ovipositor suggests that it attacks concealed hosts.

Phylogenetic Information. *Cremnoptoides* is a member of the tribe Cremnoptini but exemplars have not been included in published phylogenetic analyses. Our unpublished analyses of COI and D2–3 28S sequence data place it as sister to *Cremnops*.

Diagnosis: Fore and midtarsal claws bifid (Fig. 2a); ovipositor as long as metasoma (Fig. 31a); notauli complete (as in Fig. 12aa); lateral carina of frons acute and directed towards lateral ocellas (Fig. 6bb); gena and mouthparts slightly elongate (Fig. 31a); sternaulus complete to epicnemium, composed of a series long, shallow, vertical grooves (Fig. 31a); hind trochantellus with a pair of longitudinal carinae.

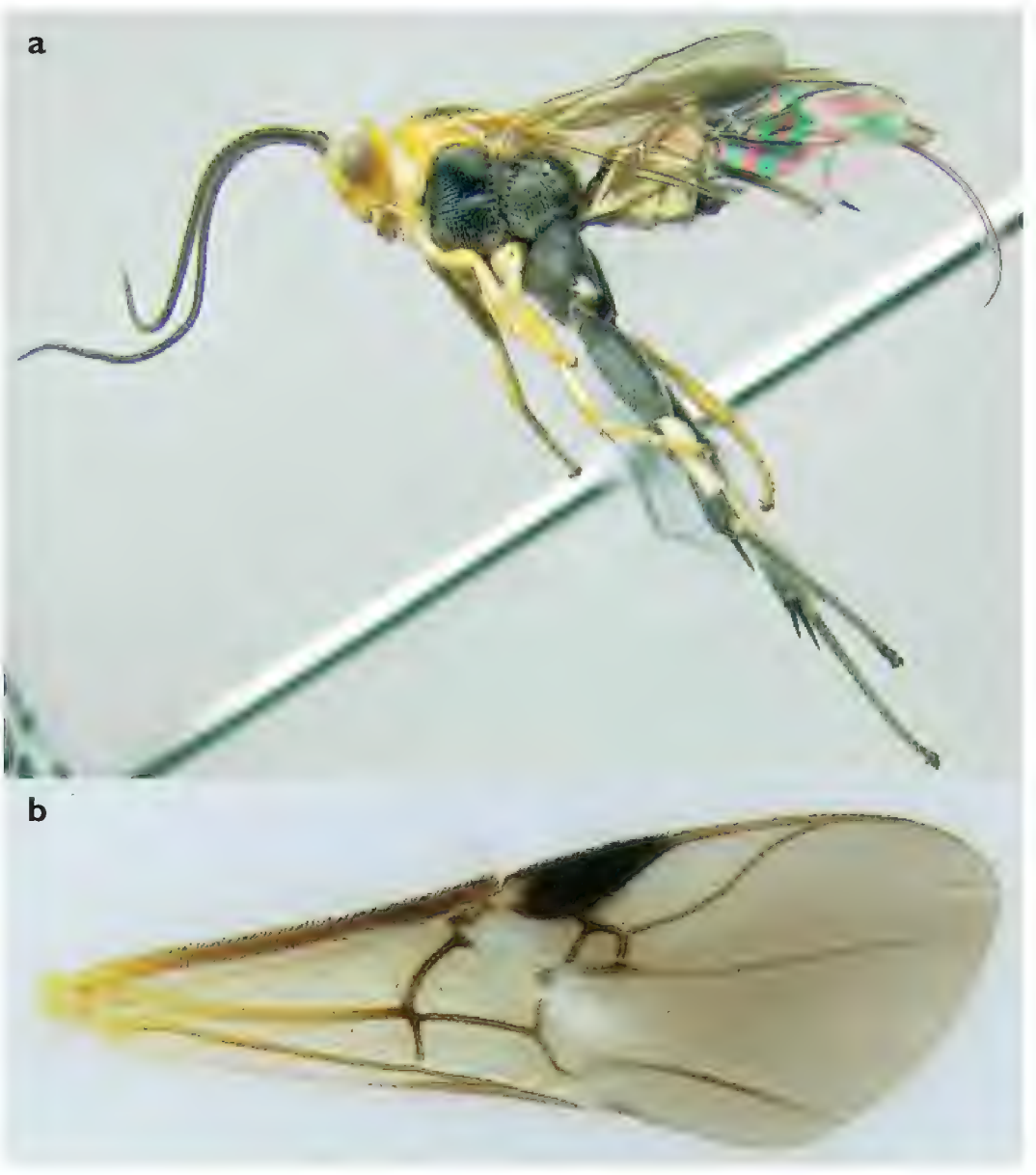


Figure 31. *Cremnoptoides* sp. **a** lateral habitus **b** forewing

Disophrys Foester, 1862

Type species: *Agathis caesa* Klug, 1835.

Megagathis Costa, 1888, first synonymized by Marshall (1900), and confirmed by Papp (1993), Simbolotti and van Achterberg (1999) and Belokobyskij et al. (2003). The type of *Megagathis*, *Agathis imperalis* Costa, 1888, was treated by Marshall (1900) as a junior synonym of *Disophrys caesa* (Klug, 1835), thereby effectively synonymizing the genera.

Pseudagathis Kriechbaumer, 1894, first synonymized by Szépligeti (1904) and confirmed by Brues (1926), Watanabe (1937), Shenefelt (1970) and Chou and Sharkey (1989). Type species: *Pseudagathis calabarica* Kriechbaumer, 1894.

Diophrys Kriechbaumer, 1898. Unjustified emendation for *Disophrys* Foerster.

Pseudocremnops Szépligeti, 1915, synonymized by Sharkey et al. (2006). Type species: *Pseudocremnops atripennis* Szépligeti, 1915.

Distribution: Old World, primarily tropical: African, Oriental, and Australian regions, with a few Palaearctic species. No specimens have been recorded from Thailand but we have collected four species represented by 5 specimens, suggesting that there are considerably more.

Diversity: Bhat and Gupta (1977) recorded 23 species from the Oriental region and Bhat (1978) added 2 new Oriental species.

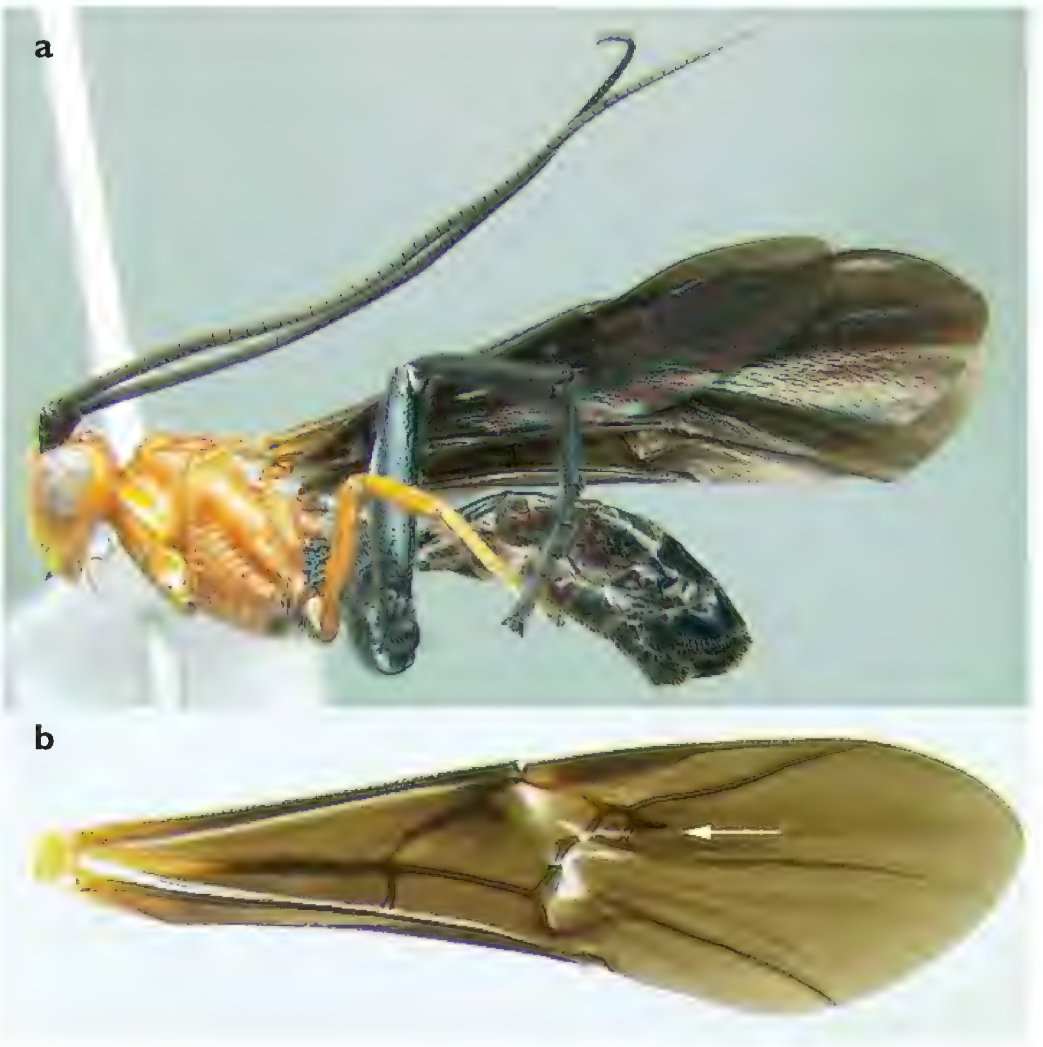


Figure 25. *Disophrys* sp. **a** lateral habitus **b** forewing

Biology: Most host records are on Noctuidae and the short ovipositors suggest that exposed hosts are attacked.

Phylogenetic Information. Sister to all other Disophrini that were included in the Sharkey et al. (2006) analyses.

Diagnosis: Lateral carina of frons lamellate (high and thin) (Fig. 11b); ovipositor barely exerted or sometimes hidden by hypopygium (Fig. 25a); second cubital cell quadrate, not narrowed anteriorly (Fig. 25b); foretibial spur not as long as basitarsus (as in Fig. 4b); hind trochantellus lacking carinae ventrally (as in Fig. 3b).

Earinus Wesmael, 1837

Type species: *Microdus delusor* Wesmael, 1837.

Diatmetus Förster, 1862, first synonymized by Szépligeti (1904) and confirmed by Muesebeck (1927), Watanabe (1937), Mueseback and Walkley (1951), Shenefelt (1970), Gupta and Bhat (1974), Bhat and Gupta (1977), Marsh (1979), Chou and Sharkey (1989) and Braet (2002). Type species: *Microdus gloriator* Nees, 1812.

Distribution: Holarctic, Oriental, austral region of South America, especially diverse in cold temperate areas. Species described from Chile as *Earinus* are sister to the Hol-

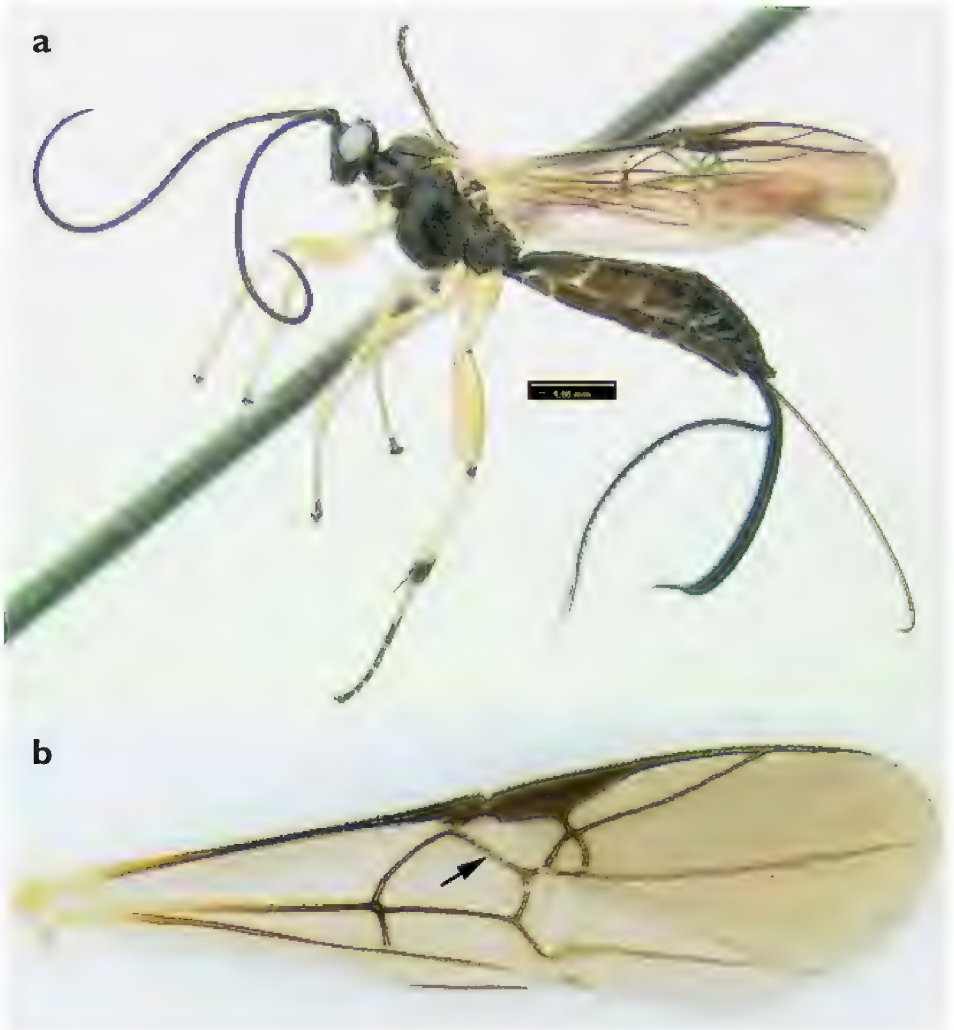


Figure 26. *Earinus* sp. **a** lateral habitus **b** forewing

arctic and Oriental clade (Sharkey et al. 2006). There are no records from Thailand but we have captured one specimen.

Diversity: 15 species are described world-wide, and 3 from the Oriental region. Bhat and Gupta (1977) recorded only one species from the Oriental region. There are many undescribed species in Austral South America.

Biology: Most host records are on Noctuidae and Tortricidae.

Phylogenetic Information. Sister to all other Earinini (Sharkey et al. 2006; and new unpublished data).

Diagnosis: This is the only agathidine genus in the Oriental region with a complete RS+M vein in the fore wing (Fig. 26b).

Euagathis Szépligeti, 1900

Type species: *Euagathis bifasciata* Szépligeti, 1900.

Chromomicrodus Ashmead, 1900, first synonymized by Baltazar (1961) and confirmed by Shenefelt (1970), Bhat and Gupta (1977), Chou and Sharkey (1989), Simbolotti and van Achterberg (1995), Sharkey (1996, 1998), van Achterberg and Chen (2002), van Achterberg (2004a, b) and van Achterberg and Raychaudhuri (2004). Type species: *Chromomicrodus abbotti* Ashmead, 1900.

Holcotroticus Cameron, 1902, first synonymized by Simbolotti and van Achterberg (1995) and confirmed by van Achterberg and Chen (2002), van Achterberg (2004a, b) and van Achterberg and Raychaudhuri (2004). Type species: *Holcotroticus ruficollis* Cameron, 1902.

Balcemena Cameron, 1903, synonymized by van Achterberg and Chen (2002), confirmed by van Achterberg (2004a, b) and van Achterberg and Raychaudhuri (2004). Type species: *Balcemena longicollis* Cameron, 1903.

Distribution: Old World, primarily tropical: African, Oriental, and Australian regions, with a few incursions into the East Palaearctic. We have collected about 10 species in Thailand represented by 152 specimens.

Diversity: Bhat and Gupta (1977) recorded 46 species from the Oriental region, they also reported 6 species of *Belcemena* which is now considered a junior synonym, making the total 52. Four species have been recorded from Thailand, viz., *E. abbotti* (Ashmead 1900), *E. chinensis* (Holmgren 1868) (as *E. semiflava* Szépligeti, 1908), *E. forticarinata* (Cameron 1899) and *E. longicollis* (Cameron, 1903) (Bhat and Gupta 1977, Simbolotti and van Achterberg 1995, Quicke et al. 2008).

Biology: Most host records are on Lymantriidae and the short ovipositors suggest that exposed hosts are attacked.

Phylogenetic Information. Rather unplaced within the Disophrini based on Sharkey et al. (2006) although many analyses placed it as sister to *Amputostypos* (as *Hypsostypos* in Sharkey et al (2006)) and unpublished COI and 28S sequence data support this placement.

Figure 27. *Euagathis* sp. **a** lateral habitus **b** forewing

Diagnosis: Claws cleft (Fig. 2a); frons lacking lateral carinae (Fig. 9a); hind trochantellus lacking ventral carinae (Fig. 3b); ovipositor much shorter than metasoma (Fig. 27a).

Gyrochus Enderlein, 1920

Type species: *Gyrochus helvus* Enderlein, 1920.

Distribution: Recorded from Sumatra, Peninsular Malaysia, and Yunnan Prov. China. Not recorded from Thailand but this rare genus undoubted occurs there.

Diversity: 4 described species, 3 species were included in Bhat & Gupta (1977).

Biology: No host records but and the short ovipositors suggest that exposed hosts are attacked.

Phylogenetic Information: A member of the Disophrini, but not included in any phylogenetic analyses.

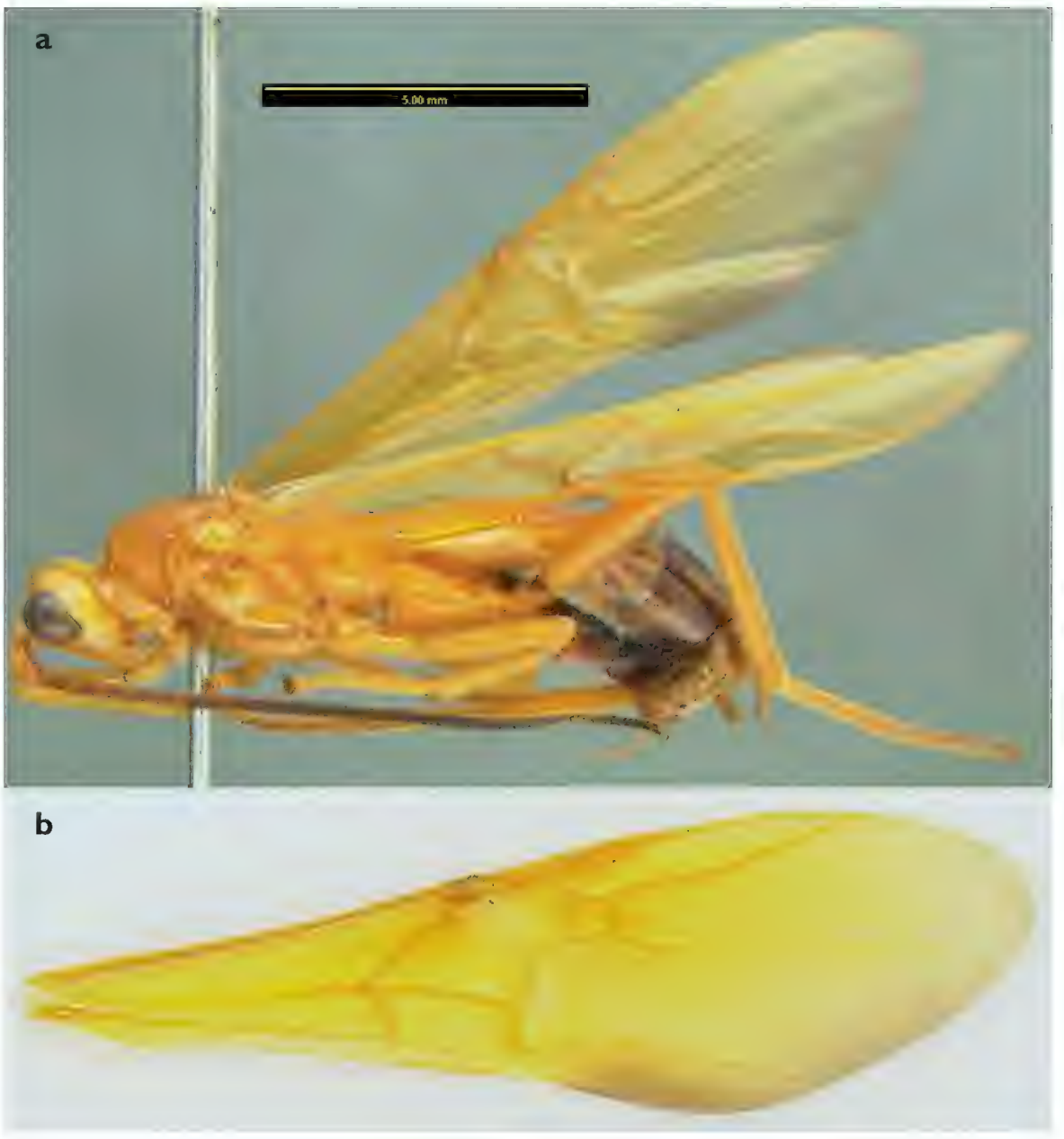


Figure 28. *Gyrochus* sp. **a** lateral habitus **b** forewing

Diagnosis: Tarsal claws bifid (Fig.2a); notauli lacking (as in Fig. 7a), ovipositor short (Fig. 28a), hind trochantellus lacking ventral carinae (Fig. 3b); lateral and medial carinae of frons joined posteriorly completely surrounding base of antennae (Fig. 8b).

Hypsostypos Baltazar, 1963

Type species: *Agathis rugifrons* Smith, 1860.

Distribution and Diversity: The genus is only represented in the literature by the type species from Sulawesi, though we have seen another specimen representing an undescribed species from Sulawesi. Due to its rarity and proximity to Thailand it may occur there as well.

Taxonomy: See the Taxonomy section under *Amputostypos*.

Biology: The short ovipositor suggests that exposed hosts are attacked.

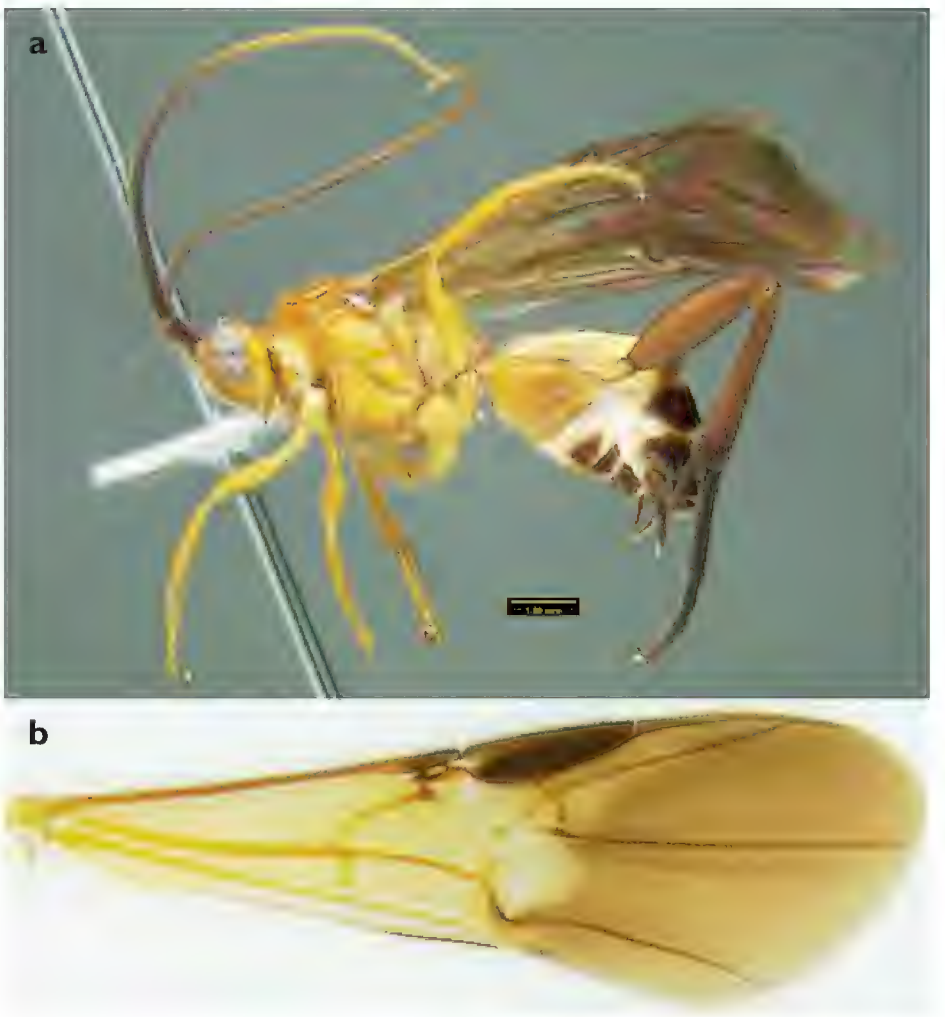


Figure 29. *Hypsostypos* sp. **a** lateral habitus **b** forewing

Phylogenetic Information. Member of the tribe Disophrini but exemplars have not been included in phylogenetic analyses.

Diagnosis: Tarsal claws bifid (Fig. 2a); ovipositor short, barely exerted (Fig. 29a); antennal sockets surrounded on three sides by tubular shaped projection (Fig. 6aa); hind trochantellus with strong pair of carinae ventrally (Fig. 3a).

Lytopylus Förster 1862, stat. n.

Type species: *Lytopylus azygos* Viereck, 1905.
Aerophilina Enderlein, 1920, syn. n. Type species: *Aerophilina bicristata* Enderlein, 1920.
Aerophilopsis Viereck, 1913, syn. n. Type species: *Bassus erythrogaster* Viereck, 1913.
Facilagathis van Achterberg & Chen, 2004, syn. n. Type species: *Facilagathis spinulata* van Achterberg & Chen, 2004.
Hormagathis Brues, 1926, syn. n. Type species: *Hormagathis mellea* Brues, 1926.
Ioxia Enderlein, 1920, syn. n. Type species: *Ioxia faceta* Enderlein, 1920.
Neomicrodus Szépligeti, 1908, syn. n. Type species: *Neomicrodus boliviensis* Szépligeti, 1908.
Obesomicrodus Papp, 1971, syn. n. Type species: *Obesomicrodus niger* Papp, 1971.

Taxonomy. Sharkey et al. (2006) demonstrated the polyphyly of the generic concept *Bassus* as it has been used over the past few decades (Nixon 1986, Simbolotti and van Achter-

berg 1992, Sharkey 1997), and further showed that a stricter sense of *Bassus* was a monophyletic group and sister to *Braunsia*. However they did not examine the type specimen of *Bassus* which does not happen to belong to the same clade as the specimens included in their analyses. Here we have selected the oldest available name for what was referred to as *Bassus* s.s. in Sharkey et al. (2006). *Lytopylus* was first proposed by Förster 1862 but no species were assigned to the genus until Viereck (1914) included *L. azygos* as the type.

Distribution: Cosmopolitan, with more diversity in temperate regions. Only one species of *Lytopylus* has been collected in Thailand but the occurrence of more members of the genus is likely. Bhat and Gupta (1977) included members of *Lytopylus* under *Agathis*. These include *L. aequoreticulatus* (Bhat & Gupta, 1977), *L. astioles* (Nixon, 1950), *L. burmensis* (Bhat & Gupta, 1977), *L. phillipinensis* (Bhat & Gupta, 1977) and *L. romani* (Shestakov, 1940) all new combinations.

Diversity: Highly speciose.

Biology: Most commonly attacking species of Tortricidae and Pyralidae, other reliable records include: Elachistidae, Gelechiidae, and Thyrididae. Undoubtedly many other host families will be confirmed or discovered.

Phylogenetic Information. Sister to *Braunsia* (as *Bassus* s.s. in Sharkey et al. 2006).

Diagnosis: Metasomal median tergites 1–3 sculptured (Fig.14a), first median tergite with prominent lateral longitudinal carinae defining a median elevated area;

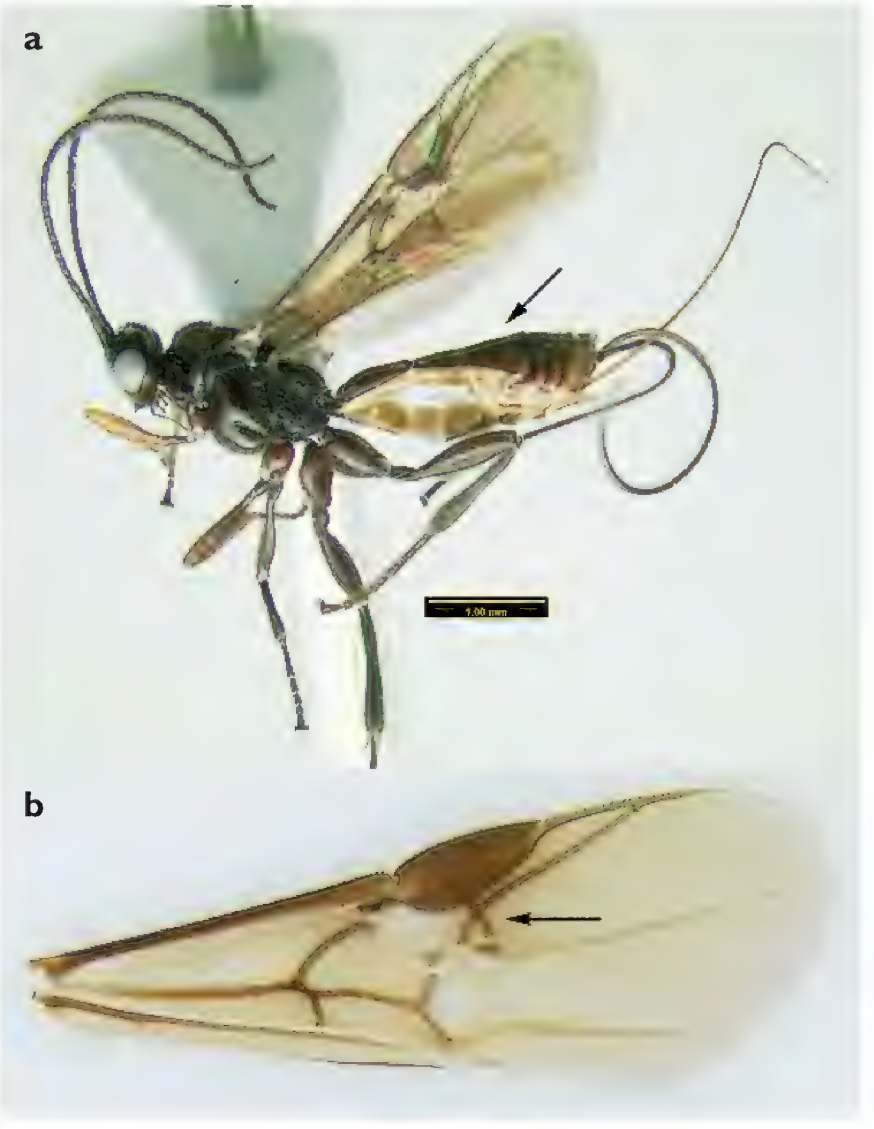


Figure 30. *Lytopylus* sp. **a** lateral habitus **b** forewing

second submarginal cell lacking adventitious 2RS vein (Fig. 30b). This diagnosis does not work well for other regions.

Therophilus Wesmael 1837, stat. n.

Type species: *Microdus (Therophilus) conspicuous* Wesmael, 1837
Aeorphiliodes Strand, 1911, syn. n. Type species: *Aerophiliodes testaceator* Strand, 1911.
Agathiella Szépligeti, 1902, syn. n. Type species: *Agathiella pedunculata* Szépligeti, 1902 Brullé.
Baeognatha Kokujev, 1903, syn. n. Type species: *Baeognatha turanica* Kokujev, 1903.
Orgiloneura Ashmead, 1900, syn. n. Type species: *Orgiloneura antipoda* Ashmead, 1900.

Taxonomy. Based on the results of Sharkey et al. (2006) we have broken the former concept of *Bassus* into several large monophyletic genera, e.g., *Lyptopylus*, *Camptothlipsis*, however not all of the problems with the old concept of *Bassus* are solved and *Therophilus* is here used to contain the polyphyletic assemblage that remains. Clearly there is improvement to be made however it seems better to recognize large monophyletic groups within the former concept of *Bassus*. If monophyly were the only criterion many agathidine genera would need be lumped into one genus.

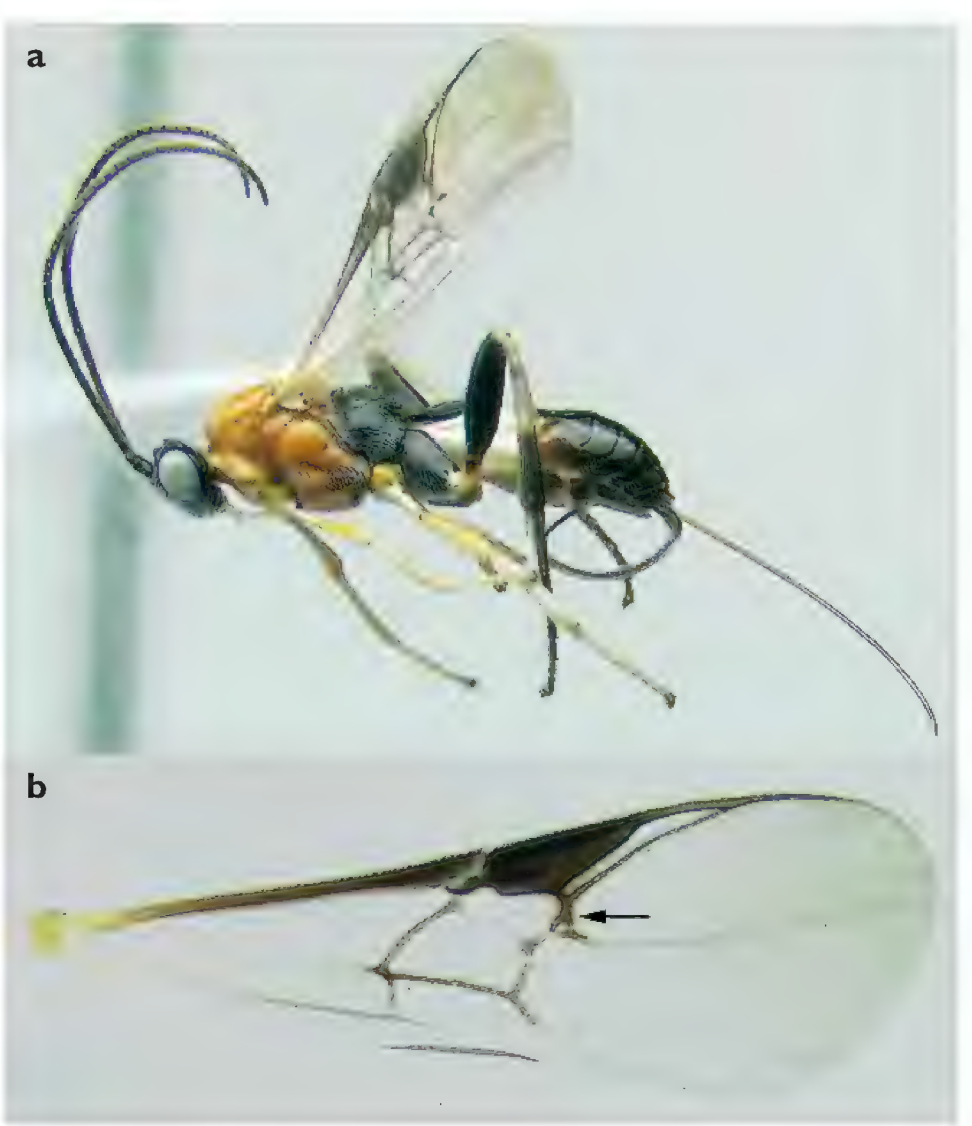


Figure 32. *Therophilus* sp. **a** lateral habitus **b** forewing

Distribution: Cosmopolitan. No species have been recorded for Thailand but we have collected 35 species.

Diversity: This polyphyletic genus is very rich and contains about as many species as all other genera combined.

Biology: Attacking a wide assortment of primarily micro-Lepidoptera, mostly in concealed microhabitats. Undoubtedly many other host families will be confirmed or discovered.

Phylogenetic Information. Polyphyletic (Sharkey et al. 2006).

Diagnosis: Ovipositor longer than metasoma (Fig. 32a); gena and mouthparts not elongate (Figs. 16b, 32a); tarsal claws with a basal lobe (Fig. 2b); metasomal cavity positioned partly between hind coxal cavities (Fig. 14bb); median tergite 3 lacking sculpture (Fig. 14b).

Troticus Brullé, 1846

Type species: *Troticus ovatus* Brullé, 1846.

Distribution: Most species are recorded from sub-Saharan Africa (Braet 2001) although a few specimens have been captured in Egypt and one in Italy, Sicily (Fahringer

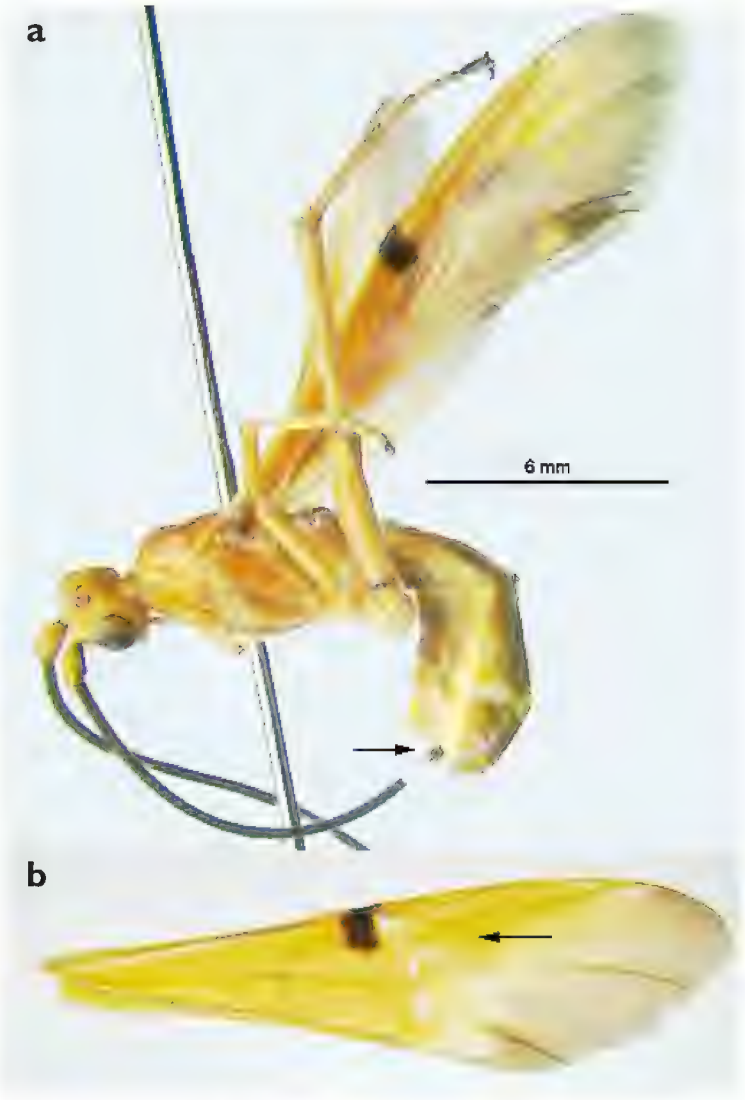


Figure 33. *Troticus* sp. **a** lateral habitus **b** forewing

1937, van Achterberg 2008). We have collected one specimen from Thailand. It is the first record from the Oriental region.

Diversity: 13 species are described, one Palaearctic and 12 Ethiopian.

Biology: Recorded from Lasiocampidae (van Achterberg et al. 2008).

Phylogenetic Information. Member of the tribe Disophrini but exemplars have not been included in phylogenetic analyses.

Diagnosis: Tarsal claws bifid (Fig. 2a); ovipositor short, barely exerted (Fig. 33a); notauli complete (as in Fig. 12aa); lateral carina of frons acute and directed towards median ocellus (Fig. 11a); epicnemial carina with an acute angle (Fig. 33a).

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Appendix 1.

Interactive key, in Intkey format, to the Oriental genera of Agathidinae (Hymenoptera, Braconidae). doi:10.3897/zookeys.21.271.app.1.ik.

Note: To run the identification key, you will need Windows 95/NT or a later version. You also need to download Intkey software and reboot your computer, if it is not already installed. The software package, Intkey, can be downloaded from http://delta-intkey.com/www/programs.htm. Once Intkey is installed you need only click on the .ik link (above) and the key will open. Click on any character on the left to begin. More details on how to use Intkey efficiently are found at http://florabase.calm.wa.gov.au/help/keys/intkey_tutorial.pdf.

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Citation: Sharkey MJ, Yu DS, van Noort S, Seltmann K, Penev L (2009) Interactive key, in Intkey format, to the Oriental genera of Agathidinae (Hymenoptera, Braconidae). doi:10.3897/zookeys.21.271.app.1.ik. Dataset published in: Zookeys 21: 19–54. doi:10.3897/zookeys.21.271.

Appendix 2.

DELTA data matrix, images, and other files to the key of the Oriental genera of Agathidinae (Hymenoptera, Braconidae). doi:10.3897/zookeys.21.271.app.2.ik.

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Appendix 3.

Lucid Interchange Format version 3 (LIF3) and Lucid SDD files to the key of the Oriental genera of Agathidinae (Hymenoptera, Braconidae). doi:10.3897/zookeys.21.271.app.3.ik.

The LIF3 file is an XML-based file that stores all the Lucid3 key data, allowing exchange of the key with other key developers. The Lucid SDD file is a XML-based file structured using the internationally agreed SDD (Structure of Descriptive Data) Schema. The SDD file may be used to exchange the Lucid key with other SDD-compliant applications.

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Appendix 4.

MX data files (NEXUS, Character list with image ids, OTU list with image ids, images) to the key of the Oriental genera of Agathidinae (Hymenoptera, Braconidae). doi:10.3897/zookeys.21.271.app.4.ik.

Note: MX keys are Web based. To build new keys a user must either obtain an account with an existing instance of MX or a new installation on a machine that runs a Web server. Basic installation instructions are found on the MX wiki (http://purl.oclc.org/net/mx-installation) and presently requires fairly advanced technical experience. MX is coded in Ruby on Rails with a MySQL database.

Present files contain MySQL database-generated output describing components of the key. These include: a character/character state list, and NEXUS file. Images are also made available and linked to character state and Operational Taxonomic Unit (OTU) descriptions. These output files are adequate to properly recreate the key, but the format of these files (except the NEXUS file) are presently under review and should not be considered standardized output at the present time.

To run the key a user needs Internet access and the key URL (http://peet.tamu.edu/projects/36/public/multikey/show/199). MX is optimized for Firefox Web browser.

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Citation: Sharkey MJ, Yu DS, van Noort S, Seltmann K, Penev L (2009) MX data files (NEXUS, Character list with image ids, OTU list with image ids, images) to the key of the Oriental genera of Agathidinae (Hymenoptera, Braconidae). doi:10.3897/zookeys.21.271.app.4.ik. Dataset published in: Zookeys 21: 19–54. doi:10.3897/zookeys.21.271.